LAKE CLASSIFICATION REPORT FOR MCGINNIS LAKE, ADAMS COUNTY

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EXECUTIVE SUMMARY

Background Information about McGinnis Lake

McGinnis Lake is a 33-acre impoundment (man-made lake) located in the Town of New Chester, Adams County, in the Central Sand Hill Area of Wisconsin. It was developed in 1965 by impounding ten acres of wetlands. McGinnis Lake is the headwaters of Neenah Creek. The greater Neenah Creek Watershed was declared a priority watershed in 1992. Neenah Creek flows out of McGinnis Lake about mid-lake. The lake itself has two distinct lobes: the north lobe is deep and partly developed; the south lobe is much shallower and fully developed. There is a public boat ramp, operated by the Adams County Parks Department, located on the southeast end of the lake. The dam is owned and operated by Adams County.

The lake is managed by the McGinnis Lake Association. There is an approved lake management plan that is annually reviewed that guides the management. Application to become a lake district is being pursued.

The primary soil type in both the surface and ground watersheds is sand. The other soil type with significant presence in both watersheds is loamy sand. There are also pockets of muck, sandy loam, and silt loam.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also drought hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought.

Land Use in McGinnis Lake Watersheds

The surface watershed for McGinnis Lake is smaller than the ground watershed. The ground watershed land use has a much higher portion of agriculture than the surface watershed. In the surface watershed, the residential land use dominates. The two largest land uses in the ground watershed are woodlands and non-irrigated agriculture.

McGinnis Lake has a total shoreline of 1.4 miles (7392 feet). The entire shore of the lakeshore is in residential use. Some of the areas at the northwest of the lake (deep lobe) are steeply sloped; the land is flatter on most of the lake. Several buildings on the east lobe of the lake are located fairly closely to the lake; buildings on the north lobe tend to be further back from the shore.

Less than half (46.4%) of McGinnis Lake's shoreline is vegetated with native vegetation. A 2004 shore survey showed that a small portion of the shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with mowed lawns, rock or hard structures and /or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.

Adequate buffers on McGinnis Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water grow without mowing it, or by planting native seedlings sufficient to fill in the first 35 feet. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information McGinnis Lake. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on the lake from the WDNR in a series of tests in 1992, from a lake study report published in 2003, and from Self-Help Monitoring records from 2002-2003.

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excessive plant growth. The average for McGinnis Lake was 28.91 micrograms/liter. This average is under the 30 micrograms/liter level recommended to avoid nuisance algal blooms. This concentration suggests that McGinnis Lake overall is not likely to have nuisance algal blooms from excessive phosphorus, but localized blooms will probably still occur, especially in the shallower southern lobe.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in McGinnis Lake in 2004-2006 was 5.91 feet. This is very good water clarity.

Chlorophyll-a concentration provides a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-200 growing season (June-September) average chlorophyll-a concentration in McGinnis Lake was 2.3 micrograms/liter, a very low algal concentration for an impoundment.

McGinnis Lake water testing results showed "very hard" water with an average of 171.69 milligrams/liter CaCO3. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

A lake with a neutral or slightly alkaline pH like McGinnis Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at McGinnis Lake, since its surface water alkalinity averages 156.89 milliequivalents/liter. The pH levels from the bottom of the lake to the surface hovered between nearly 7 and 8, alkaline enough to buffer acid rain.

Most of the other water quality testing at McGinnis Lake showed no areas of concern. The average calcium level in McGinnis Lake's water during the testing period was 32.06 milligrams/liter. The average Magnesium level was 19.42 milligrams/liter. Both of these are low-level readings. Both sodium and potassium levels in McGinnis Lake are very low: the average sodium level was 1.76 milligrams/liter; the average potassium reading was 0.58 milligrams/liter.

To prevent the formation of hydrogen sulfate gas, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Sulfate levels in McGinnis Lake are 8.91 milligrams/liter, above the level for formation of hydrogen sulfate, but below the health advisory level. Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Very turbid waters may not only smell and mask bacteria & other pollutants, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for McGinnis Lake were at low levels between 2004-2006.

Other water testing included looking at chloride and nitrogen levels. The presence of a significant amount of chloride over a period of time may indicate that there are negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. Chloride levels found in McGinnis Lake during the testing period averaged 1.35 milligrams/liter, considerably lower than the natural level of 3 milligrams/liter for this region of Wisconsin. Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). McGinnis Lake's combination spring levels from 2004 to 2006 average 0.11 milligrams/liter, considerably below the .3 milligrams/liter predictive level.

Phosphorus

Like most lakes in Wisconsin, McGinnis Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other water quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a man-made lake like McGinnis Lake, a total phosphorus concentration below 30 micrograms/liter tends to result in few nuisance algal blooms. McGinnis Lake's growing season (June-September) surface average total phosphorus level of 28.91 micrograms/liter is under that limit, suggesting that phosphorus-related nuisance algal blooms are unlikely to occur lake wide.

Land use plays a major role in phosphorus loading. Currently, the most phosphorus loading is coming from the ground watershed, which includes many agricultural areas. The second largest estimated load is from septic systems. When the same model was run in the earlier 2000s, the ground watershed and in-lake loading (which would include septics) were determined to be the largest sources of phosphorus loading in the lake.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve McGinnis Lake water quality by .7 to 16 micrograms. A 25% reduction would save 1.75 to 40 micrograms/liter and reduce the overall eplimnetic growing season total phosphorus to 26.7 micrograms/liter. Such decreases would make the deep hole total phosphorus levels considerably under the 30 micrograms/liter recommended to avoid nuisance and might also reduce the levels in the shallower end and result in fewer algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect McGinnis Lake's health for future generations.

Aquatic Plant Community

The first recorded aquatic plant survey was by DNR staff in 1963. This qualitative survey showed that the plant-like algae, *Chara spp*, abundant, as was *Ceratophyllum demersum* (coontail). Water milfoil was also abundant; smartweed was common. Pondweeds were scarce, as was filamentous algae. A limited survey was done by UWSP students for *Potamogeton crispus* (Curly-Leaf Pondweed) in 2002. In 2004, a sensitive area study was done on McGinnis Lake. Aquatic vegetation found included *Ascelpias incarnata, Calamagrostis canadensis, Ceratophyllum demersum, Chara spp, Cicuta bulbifera, Iris versicolor, Myriophyllum sibiricum, Najas flexilis, Potamogeton crispus, Potamogeton illinoensis, Potamogeton pectinatus, Potamogeton richardsonii, Ranunculus longirostris, Rumex spp, Salix spp, Scirpus validus* and *Typha latifolia.* Substantial filamentous algae were also noted.

Another aquatic macrophyte (plant) field study of McGinnis Lake was conducted during June 2006 by a staff member of the Wisconsin Department of Natural Resources and a staff member of the Adams County Land and Water Conservatism Department. Of the 39 species found in McGinnis Lake in 2006, 37 were native and 2 were exotic invasives. In the native plant category, 23 were emergent, 3 were free-floating plants, 1 was a floating-leaf rooted type, and 10 were submergent types. Two exotic invasives, *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed, were found.

The invasive aquatic plant, *Potamogeton crispus* (Curly-Leaf Pondweed) was the most frequently-occurring plant in McGinnis Lake in 2006, followed by the native aquatic plants, *Ceratophyllum demersum* (coontail), *Myriophyllum sibiricum* (northern watermilfoil) and *Potamogeton pectinatus* (Sago pondweed). No other species reached a frequency of 50% or greater. Filamentous algae were found at 86.27% of the sample sites.

Potamogeton crispus was also the densest plant in McGinnis Lake. Other dense plants were *Ceratophyllum demersus,*, *Myriophyllum sibiricum* and *Potamogeton pectinatus*. No aquatic plants occurred at greater than average density overall. However, in Depth Zone 2 (1.5 feet-5 feet), *Potamogeton pectinatus* and *Potamogeton crispus* occurred at more than average mean density. In Depth Zone 3 (5 feet-10 feet), *Myriophyllum sibiricum, Potamogeton crispus* and *Potamogeton pectinatus* all occurred at more than average density. *Ceratophyllum demersum* occurred at above average density in Depth Zone 4 (10 feet-20 feet).

Potamogeton crispus (the invasive exotic) was the dominant aquatic plant species in McGinnis Lake during early summer. Sub-dominant were *Ceratophyllum demersum, Myriophyllum sibiricum* and *Potamogeton pectinatus*. *Phalaris arundinacea*, the other exotic found at McGinnis Lake, was not present in high frequency, high density or high dominance.

Based on water clarity, chlorophyll and phosphorus data, McGinnis Lake is a mesotrophic impoundment with good water clarity and fair to good water quality. This trophic state should support abundant plant growth and occasional algal blooms. The Average Coefficient of Conservatism of the aquatic plant community in McGinnis Lake is below average for Wisconsin lakes and for lakes in the North Central Hardwood region, but the Floristic Quality Index was above average. The AMCI is in the average range for both North Central Hardwood Region and all Wisconsin lakes. Filamentous algae were over-abundant. Structurally, the aquatic plant community contains emergent plants, free-floating plants, floating-leaf rooted plants and submergent plants.

<u>Critical Habitat Areas</u>

Wisconsin Rule 107.05(3)(i)(I) defines a “critical habitat areas” as: “areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes. Four areas on McGinnis Lake were determined by a team of lake professionals to be appropriate for critical habitat designation.

MG1 is extends along approximately 200 feet of shoreline and supports important near-shore terrestrial habitat composed of mature pines, shoreline habitat and shallow water habitat. The area is scenic and provides visual & sound buffers. The shoreline is 75% pine woods and 25% herbaceous growth. Most of the aquatic plants at this site were submergents. The submergents provide important habitat for the fish community. The plant-like algae, *Chara* spp. (muskgrass), was common here, as were filamentous algae. The invasive Curly-Leaf Pondweed was also present here.

MG2 is part of the old stream channel before the dam was built. This area covers 500 feet of shoreline and supports near-shore terrestrial habitat and shallow water aquatic vegetation. The shoreline is mostly covered by shrub growth, including willows. Emergent aquatic plants are common. Several submergent aquatic plant species were also present. Muskgrass and filamentous algae were present. Curly-Leaf Pondweed was also present.

Area MG3 extends along 750 feet of steep shoreline and supports important near-shore terrestrial vegetation, shoreline habitat and shallow water habitat. The shoreline was mostly wooded, with about 10% developed. Large woody cover in the shallow water serves as important fish cover and wildlife resting areas. There are springs in this area that serve as a water source for the lake. This area has multi-levels of vegetation: emergent plants, floating-leaf rooted plants, and submergent plants. Muskgrass was abundant here. No Curly-Leaf Pondweed was found at this site.

Area MG4 is also part of the old stream channel before the dam was built. The area runs along approximately 1000 feet of shore, part of which is in the channel between the two lake lobes. Both shoreline and shallow water habitat are present. About 60% of the shore is shrub buffer, with the rest of the shore about 10% wetlands and pockets of sedge meadows, and the rest developed with houses. Emergent and submergent aquatic plants were found here. The invasive Curly-Leaf Pondweed was not found here.

Fish/Wildlife/Endangered Resources

WDNR stocking records go back to 1969, when McGinnis Lake was stocked with rainbow trout, bluegills and largemouth bass. Stocking continued into the 1990s, consisting of bluegills, largemouth bass and northern pike. Fish inventories go back to 1963, when the WDNR made the following findings: bluegill and largemouth bass abundant; blackchin shiner, brassy minnow and sunfish common; mud minnow, perch and sucker scarce. A 1980 inventory recommended the installation of an aeration system because of the history of low oxygen and fish kills. Other inventories through the years also found bullheads and pumpkinseed. The most recent inventory revealed that bluegills were the most abundant fish, largemouth bass were common and pumpkinseeds were scarce.

Muskrat are also known to use McGinnis Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well. One endangered species, *Cincindela patruela* (tiger beetle), is reported in the McGinnis Lake watersheds.

Conclusion

McGinnis Lake is a mesotrophic impoundment impacted of good to very good water quality. There are problems, especially the dominance of Curly-Leaf Pondweed in this lake. The McGinnis Lake District will need to regularly review and update its lake management plan in order to address the management issues in a logical, cohesive manner.

RECOMMENDATIONS

Lake Management Plan

The McGinnis Lake District will need to regularly review and update its lake management plan in order to address the management issues needed. The plan will need to always address the following: aquatic plant management; control/management of invasive species; wildlife and fishery management; watershed management; shoreland protection; critical habitat protection; water quality protection; inventory & management of the larger watershed.

There is a fairly active Lake Advisory Group that has been invaluable in gathering information for the lake district. It is recommended that it continue.

Watershed Recommendations

Therefore, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans. If such sites are documented, steps for dealing with these issues can be incorporated into the lake management plan as needed.

Shoreland Recommendations

All lake residents should practice best management on their lake properties, including keeping septic systems cleaned and in proper condition, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.

Aquatic Plant Management Recommendations

(1) Because the plant cover in the littoral zone of McGinnis Lake is over the ideal (25%-85%) coverage for balanced fishery, consideration should be given to reducing plant growth in at least some areas. A map of areas to have plants removed should be developed, then removal should occur by hand to be sure that entire plants are removed and to minimize the amount of disturbance to the settlement.

(2) Natural shoreline restoration and erosion control in some areas are needed, especially on some steep banks around the deeper lobe of the lake. A buffer area of native plants should be restored on those sites that now have traditional lawns mowed to the water's edge. Restore natural shoreline. Disturbed shoreline covers much of the south lobe's shore, and mowed lawn alone covers over one-third of the shore.
   a) Unmowed native vegetation reduces shoreline erosion and run-off into the lake and filters the run-off that does enter the lake thus reducing nutrient inputs.
   b) Shoreline restoration could be as simple as leaving a band of natural vegetation around the shore by discontinuing mowing.
   c) Restoration could be as ambitious as extensive plantings of attractive native wetland species in the water and native grasses, flowers, shrubs and trees on the near shore area.

(3) Stormwater management of the impervious surfaces around the lake is essential to maintain the high quality of the lake water.

(4) Septic systems around the lake should be inspected regularly and maintained properly.

(5) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore.

(6) The aquatic plant management plan should be updated regularly. The plan should consider including target treatment using chemicals or target harvesting for Curly Leaf Pondweed to prevent further spread, as well as avoiding sensitive areas. Chemical treatments for plant growth are currently the most feasible way of trying to deal with the curly-leaf pondweed problems. However, continued reliance on chemicals only is not recommended due to the undesirable side effects of chemical treatments.
   a) The decaying plant material releases nutrients that feed algae growth that further reduce water clarity.
   b) The decaying material also enriches the sediments at the site.
   c) The herbicides are toxic to an important part of a lake food chain, the invertebrates.
   d) Broad-spectrum treatments would open up areas that would be vulnerable to the spread of the exotic species.

(7) Other methods of Curly-Leaf Pondweed control should be explored, including mechanical harvesting of some areas to reduce the nutrient loading currently occurring from the mid-summer die-off of Curly-Leaf Pondweed.

(8) The McGinnis Lake District may want to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.

(10) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to invasion by EWM.

(11) Fallen trees should be left at the shoreline.

(12) McGinnis Lake should participate in the Self-Help Monitoring Program through the WDNR by monitoring water quality monitoring and invasive species through the Citizen Volunteer Lake Monitoring Program. The Lake District should also have volunteers actively involved in the Clean Boats, Clean Waters program to assist in preventing the introduction of other invasives into the lake and assist in boater education.

(13) McGinnis Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(14) Critical habitat areas were formally determined in 2004. The lake management plan should include preserving these areas and following the recommendations of the 2005 Sensitive Area Report.

(15) The areas where there are undisturbed wooded shores should be maintained and left undisturbed.

(16) The McGinnis Lake District should make sure that its lake management plan that takes into account all inputs from both the surface and ground watersheds and addresses the concerns of the overall lake community.

(17) Cooperation with the Adams County Parks Department in keeping the boat ram in safe condition should help reduce any negative impacts caused by the heavy use of this public area.

Critical Habitat Recommendations

(1) Maintain current habitat for fish and wildlife.

(2) Maintain snag, cavity and fallen trees along the shore for nesting & habitat.

(3) No alteration of littoral zone unless to improve spawning habitat.

(4) Seasonal protection of spawning habitat.

(5) Maintain any snag/cavity trees for nesting.

(6) Install nest boxes.

(7) Maintain corridor and restore natural shoreline vegetations where cleared to increase wildlife corridor.

(8) Increase buffer width where it is less than 35' lakeward and install buffers where there is currently mowed grass to the shore.

(9) Designate critical habitat areas as no-wake lake areas.
(10) Protect emergent vegetation with no removal of emergent vegetation.
(11) No removal of submergent and floating-leaf vegetation. Minimize aquatic plant and shore plant removal to maximum 30' wide viewing/access corridor and navigation purposes. Leave as much vegetation as possible to protect water quality and habitat.
(12) Seasonal control of Curly-Leaf Pondweed and other invasives with methods selective for control of exotics.
(13) Use best management practices.
(14) No use of lawn products, including fertilizers, herbicides & other chemicals.
(15) No bank grading or grading of adjacent land.
(16) No pier placement, boat landings, development or other shoreline disturbance in the shore area of the wetland corridor.
(17) No pier construction or other activity except by permit using a case-by-case evaluation and only using light-penetrating materials.
(18) No installation of pea gravel or sand blankets.
(19) Install bank restoration in highly eroded areas. Otherwise, permit no bank restoration unless the erosion index scores moderate or high. Use bioengineering practices only, but not rock riprap, retaining walls or other hard armoring.
(20) No placement of swimming rafts or other recreational floating devices.
(21) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(22) Post exotic species information at public boat landing.
(23) Maintain lake as no gas motor lake.

LAKE CLASSIFICATION REPORT FOR MCGINNIS LAKE, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and education lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a relative response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. To provide the requested assistance, Adams County Land and Water Conservation Department will incorporate the lake management plans goals, priorities and action items into its Annual Plan of Operations. Goals, priorities and action items may include educational programs, formation of lake districts, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

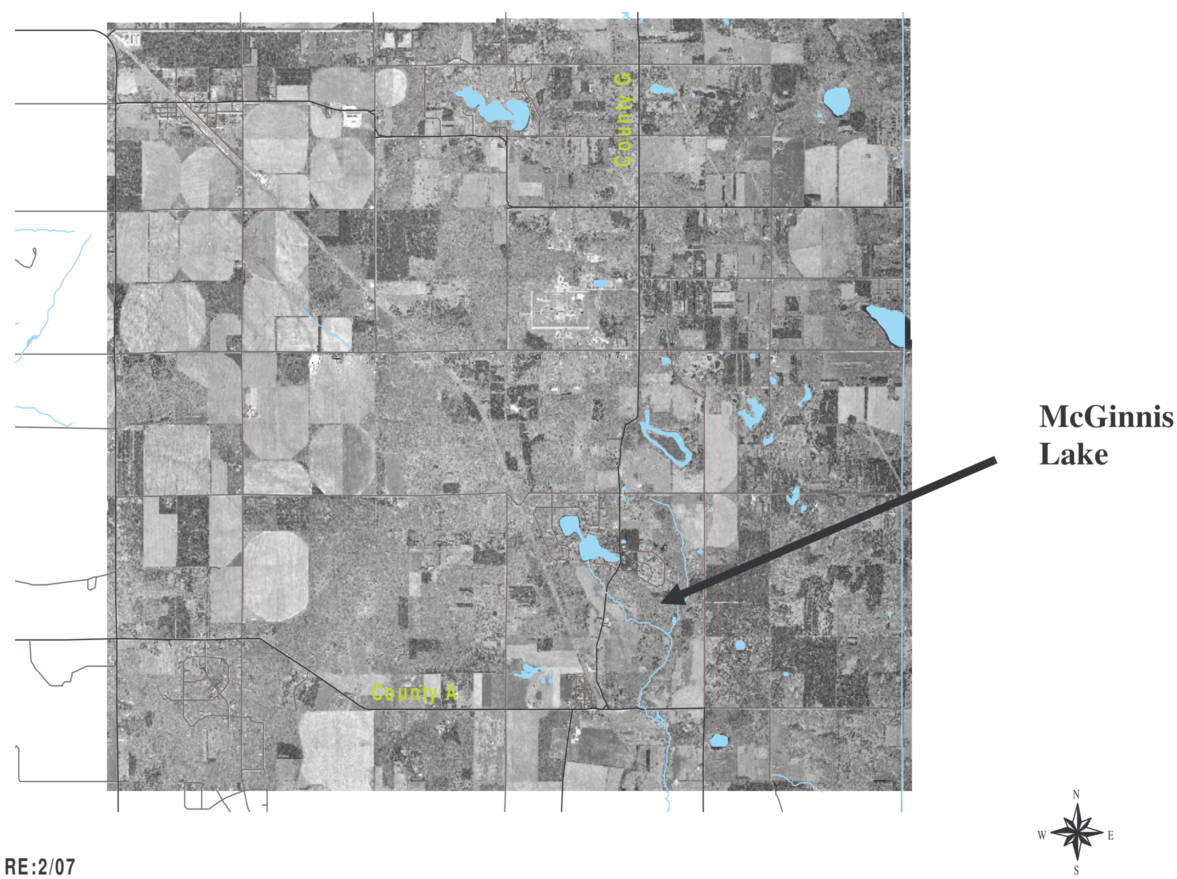
Figure 1: Adams County Location in Wisconsin

MCGINNIS LAKE BACKGROUND INFORMATION

McGinnis Lake is a 33-acre impoundment (man-made lake) located in the Town of New Chester, Adams County, in the Central Sand Hill Area of Wisconsin. It was developed in 1965 by impounding ten acres of wetlands. McGinnis Lake is the headwaters of Neenah Creek. The greater Neenah Creek Watershed was declared a priority watershed in 1992.   Neenah Creek flows out of McGinnis Lake about mid-lake. The lake itself has two distinct lobes: the north lobe is deep and partly developed; the south lobe is much shallower and fully developed. There is a public boat ramp, operated by the Adams County Parks Department, located on the southeast end of the lake. The dam is owned and operated by Adams County.

The lake is managed by the McGinnis Lake District. There is an approved lake management plan that is annually reviewed that guides the management.

Figure 2: McGinnis Lake location



The Central Sand Hills, which contain McGinnis Lake, are located on what was once Glacial Lake Wisconsin. There are a series of glacial moraines partly covered by glacial outwash and some rolling hills. Soils tend to be sandy and often calcareous. There are extensive wetlands in the outwash areas and headwaters of coldwater streams that originate in the glacial moraines. There are also many small kettle lakes and ponds associated with the pitted glacial outwash and areas of till.

Bedrock and Historical Vegetation

Bedrock around McGinnis Lake is mostly sandstone, both weak and resistant, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Dolomite is laid over the sandstone in the hilly region of end moraines. Bedrock may be 50 feet to 100 feet below the land surface.

Historic upland vegetation consisted of oak-forest, oak savanna and tallgrass prairie. Calcareous fens were common, as well as wet-mesic prairie, wet prairie, costal plain marshes, conifer swamps and sedge meadows. Many coldwater streams are also found in this area.

Soils in the McGinnis Lake Watersheds

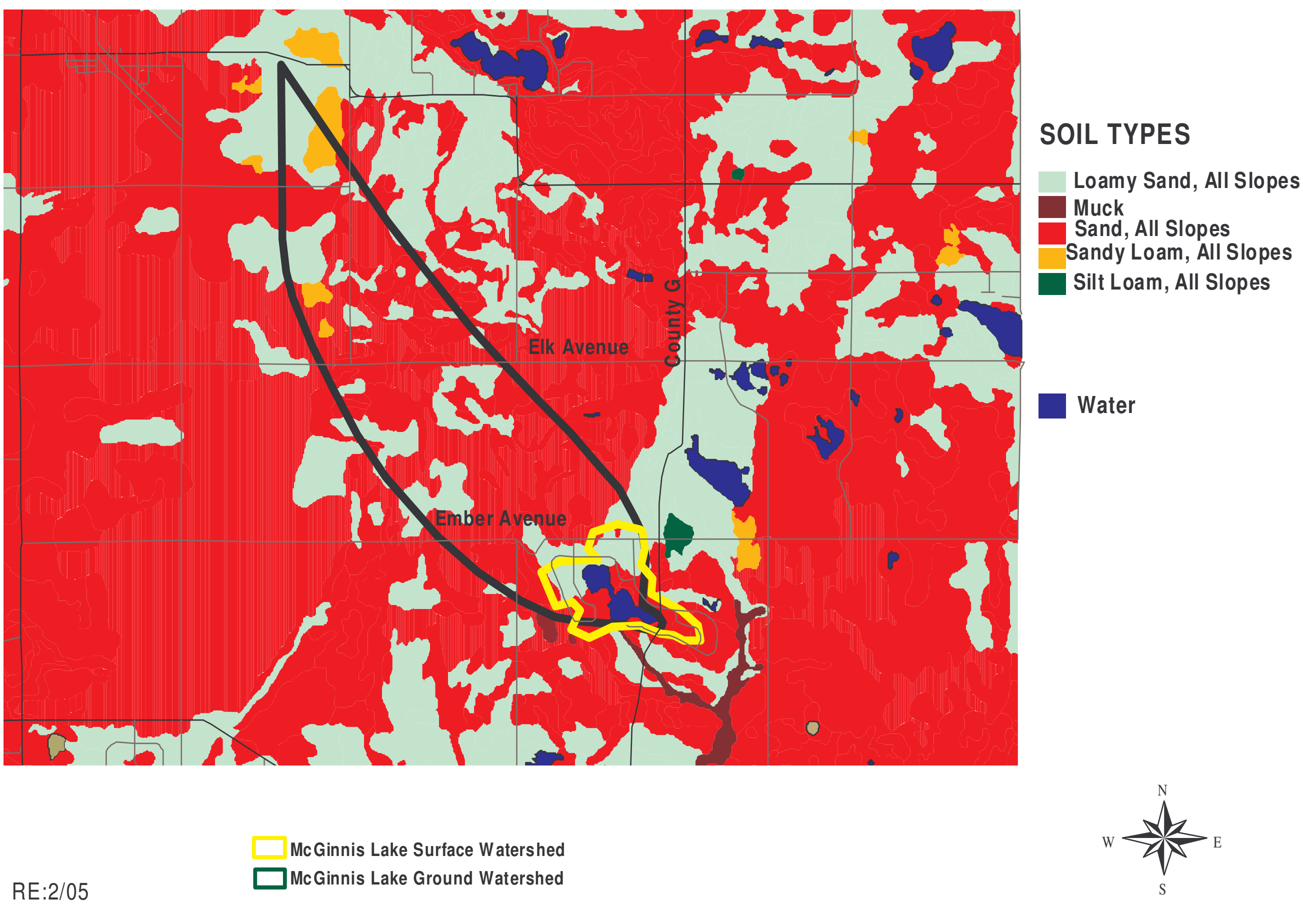
The primary soil type in both the surface and ground watersheds is sand. The other soil type with significant presence in both watersheds is loamy sand. There are also pockets of muck, sandy loam, and silt loam.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

Figure 3: MCGINNIS WATERSHEDS SOILS



PRIOR STUDIES OF MCGINNIS LAKE

With a grant from the WDNR, a study was done in the early 2000s of McGinnis Lake. As part of that study, a survey of residents of the surface watershed was made in Spring 2002. Most of the respondents owned lakefront property. 20% were permanent, full-time residents on the lake. 50% of the respondents had owned their property over 10 years.

The survey revealed that the most popular activities of the respondents were boating, fishing, peace/solitude, scenic enjoyment and swimming. Most people owned more than one boat. Respondents saw the major lake problems as weed growth and algae/scum. 50% indicated they felt the water quality in the lake had declined since they started coming to the lake.

A report on the results of the study was released in November 2003, summarizing and discussing the testing results from 2001-2002. The report was authored by A. Dechamps, N. Turyk, P. McGinley, and R. Bell of UW-Stevens Point. The report described McGinnis Lake as "exhibiting the symptoms of nutrient enrichment." Part of the purpose of the study was to evaluate and identify the sources of nutrient enrichment.

At that time, land use in the surface watershed of McGinnis Lake was found to be 49.9% woodlands; 24.5% grassland/pasture; 16.5% water; 6% agriculture; and 2.7% shrubs. The ground watershed land use was someone different: woodlands still dominated the ground watershed land use at 57%, but agriculture increased to 20.2% of the land use, grassland/pasture declined to 19.36%. Water and shrubs also declined to 2.9% and 0.5% respectively.

One of the important findings was that the deeper north lobe and the shallower southern lobe of the lake had very different characteristics due to varying depths, groundwater inputs, surrounding topography and level of shore development.

The northern lobe, with its maximum depth of 29 feet, stratifies during the growing season. The growing season average water clarity was 3.6 feet, which is poor. The average growing season surface total phosphorus level was 73 micrograms/liter. The average bottom total phosphorus was 220 micrograms/liter. Chlorophyll-a readings in the northern lobe started at 4.6 micrograms/liter and increased as the summer progressed. The northern lobe also had high hardness and alkalinity readings, those of 231 milligrams/liter of calcium carbonate and 242 milliequivalents/liter of alkalinity respectively. The pH average for the northern lobe was 7.9, slightly alkaline.

While the surface total phosphorus average is somewhat elevated for an impoundment (average impoundment surface TP in Wisconsin is 65 micrograms/liter), the bottom TP reading is extremely high. This is especially important because dissolved oxygen levels in the lower depths in the northern lobe reach hypoxic (low-oxygen) levels during the summer. The combination of the high total phosphorus levels and low oxygen readings, along with the presence of marl sediment, result in the marl going into solution, making the phosphorus it normally stores go into solution and become available for plants and algae. In addition, organic matter from the lake bottom is taking the place of phosphorus on calcium carbonate exchange sites, leaving even more phosphorus available to aquatic plants and algae. Thus, the usual benefits of marl sediment—typing up phosphorus out of the water column—are not present in McGinnis Lake's northern lobe.

The southern lobe of McGinnis Lake has a maximum depth of 10 feet. Its water remains mixed throughout the year and do not stratify. It has slightly better average water clarity at 5.2 feet, with water clarity getting worse during the summer. It has a lower surface total phosphorus level of 29 micrograms/liter. The chlorophyll-a levels rose until July, with the highest reading 10.9 micrograms/liter slightly after the die-off of Curly-Leaf Pondweed, the major invasive in McGinnis Lake. The hardness and alkalinity of the southern lobe water was lower than that of the north: average total hardness was 112 milligrams/liter of CaC03 in the southern lobe and average alkalinity was 111 milliequivalents/liter. Its pH was 8.8, more alkaline than the water in the northern lobe. The report also noted that the southern lobe contains the wetland area originally flooded to create McGinnis Lake, so that it started with the elevated organic matter and nutrients present in the wetlands.

Among the testing done for this study were evaluations of the chloride and nitrogen levels in the groundwater around the lake. 40 mini-piezometers were placed around the lake at about 200 foot intervals. It was discovered that elevated chloride levels, as well as nitrogen levels, existed near the boat landing, in the channel between the two lobes, in two littoral sections of the northern lobe and one littoral section of the southern lobe. These elevated figures, along with the reactive phosphorus readings, in the groundwater entering the lake indicated that the land use in the lake watersheds was negatively impacting the lake. Possible contributors were aging septic system, lawn or garden fertilizers, or both.

The report indicated that the lake overall was affected by in-lake loading, aging septic systems and loading from plant nutrients, especially from the Curly-Leaf Pondweed die off in late June/early July. Curly-Leaf Pondweed was found to dominate the aquatic plant community in the early spring and late fall, covering most of the southern lobe, most of the channel and part of the littoral zone in the northern lobe.

The report made the following recommendations:

- There should be intervention in the Curly-Leaf Pondweed cycle to reduce the added phosphorus & other nutrients to the lake system from the plant die-off. Mechanical harvesting should help, as well as the establishment of other native species.
- Since land-use practices appear to be negatively affecting the shallow groundwater and thus the lake, practices such as reduction/elimination of lawn/garden fertilizers, septic system monitoring, etc. should be used.
- Native plant buffers should be reintroduced, especially on the heavily-developed southern love, and protected where already established to filter sediments and nutrients, prevent erosion and provide habitat.
- Continued water monitoring should be performed.

CURRENT LAND USE

The surface watershed for McGinnis Lake is smaller than the ground watershed. The ground watershed land use has a much higher portion of agriculture than the surface watershed. In the surface watershed, the residential land use dominates. The two largest land uses in the ground watershed are woodlands and non-irrigated agriculture. (See Figures 4, 5a, 5b & 6).

Figure 4: McGinnis Lake Watersheds Land Use in Acres and Percent of Total

	Surface		Ground		Total	
McGinnis Lake						
Agriculture--Non Irrigated	6.23	1.79%	215.53	14.55%	221.76	12.12%
Agriculture--Irrigated	0	0.00%	23.2	1.57%	23.2	1.27%
Grassland/Pasture	0	0.00%	53.6	3.62%	53.6	2.93%
Residential	249.75	71.67%	133.49	9.01%	383.24	20.95%
Water	32.68	9.38%	4.72	0.32%	37.4	2.04%
Woodland	59.79	17.16%	1050.33	70.93%	1110.12	60.68%
total	348.45	100.00%	1480.87	100.00%	1829.32	100.00%

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5" out of a 4" rainfall, leaving only .5" as runoff, a residential area with quarter-acre lots may absorb only 2.3" of the 4", leaving 1.7" to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7" of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230). The changes in the McGinnis watershed land use are therefore likely to significantly increase the runoff in volume and content unless protection steps are taken.

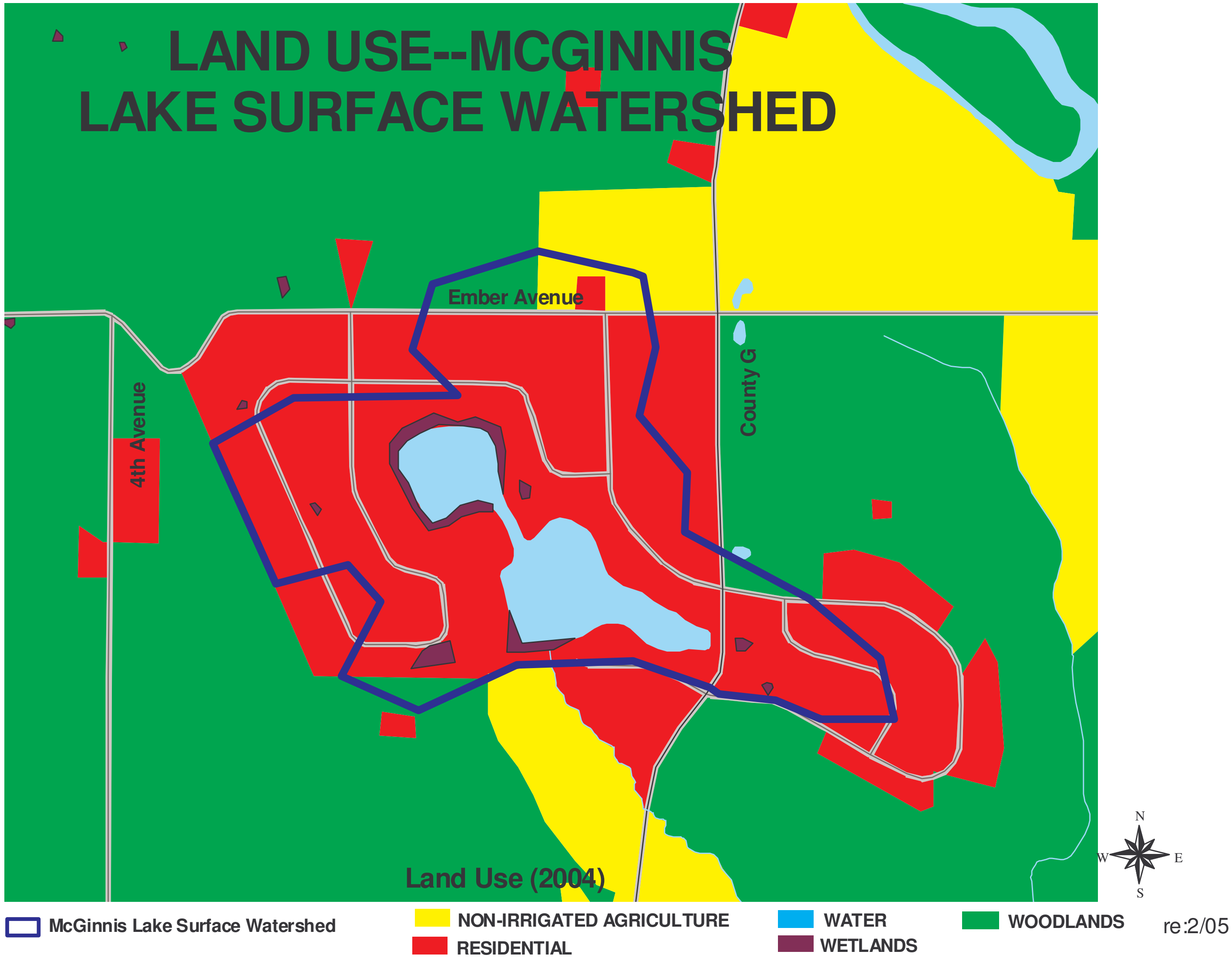
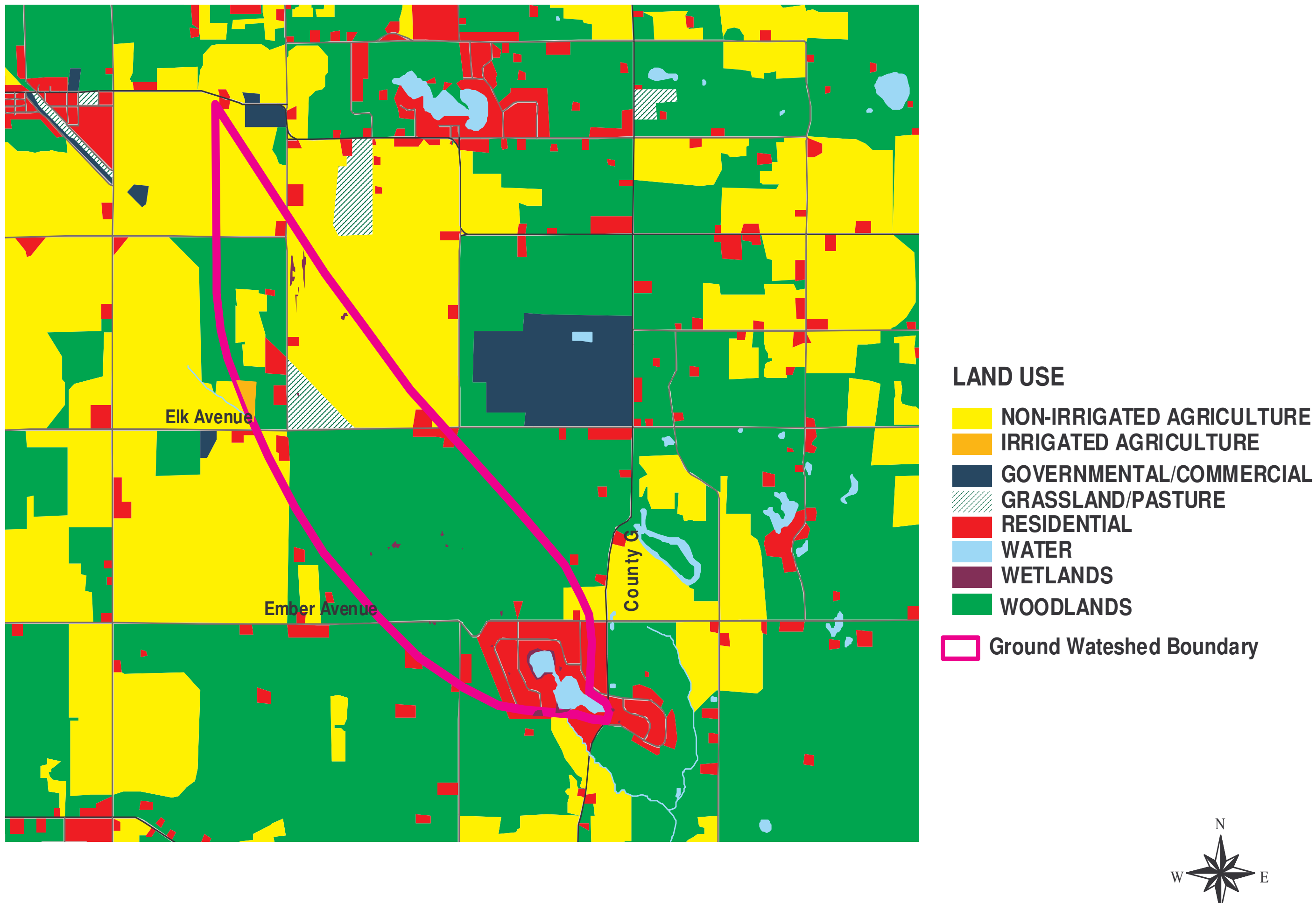


Figure 5a: Land Use in McGinnis Lake Surface Watershed

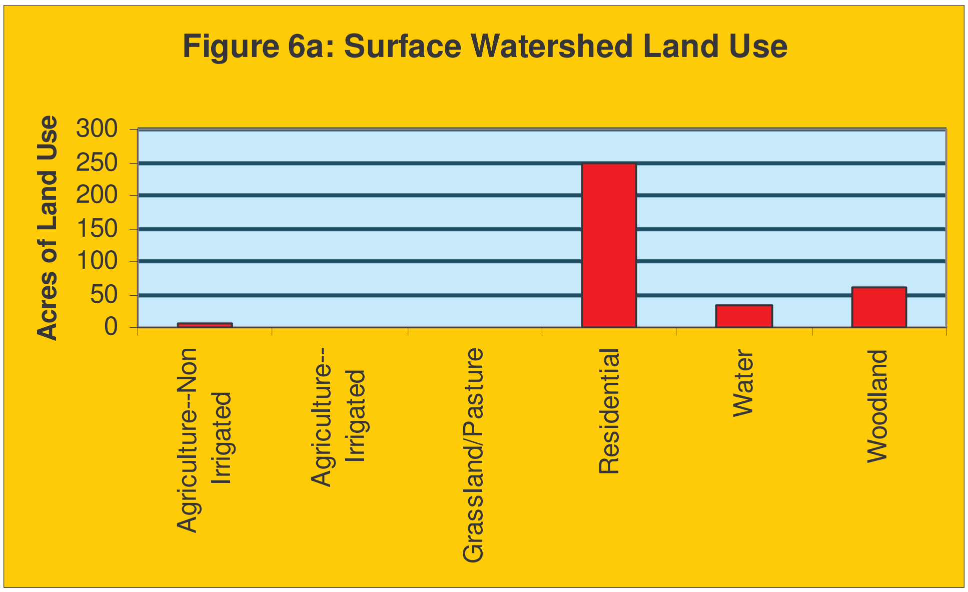
Land Use--McGinnis Lake Ground Watershed

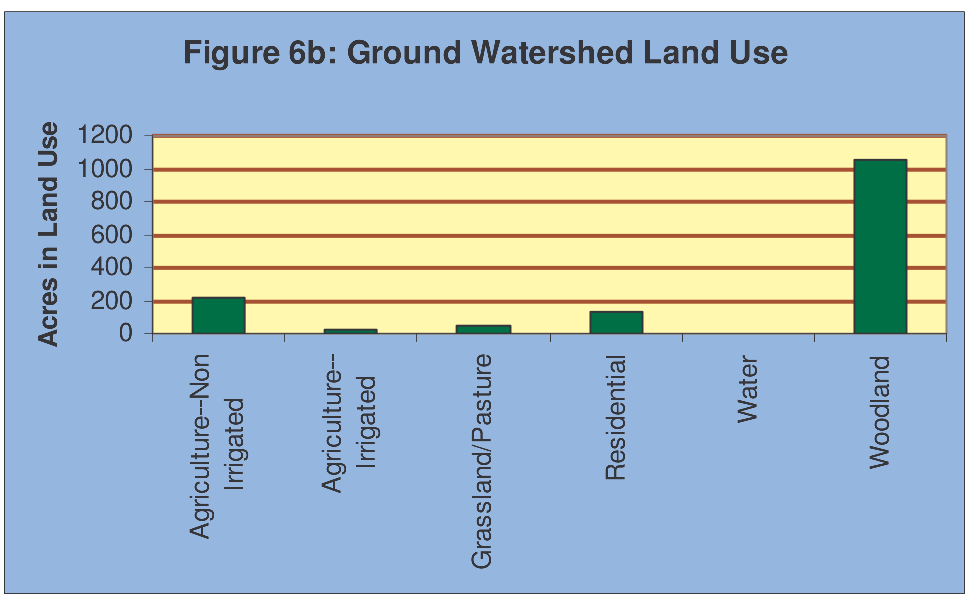


RE:2005

Figure 5b: Land use in McGinnis Lake Ground Watershed

When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There are two specific kinds of land use—wetlands and shorelands--that are so important to water quality that they will be separately discussed.

<u>WETLANDS</u>

Most of McGinnis Lake's wetlands are located around the lake itself. (Figures 5a & 5b). In the past, wetlands were seen as "wasted land" that only encouraged disease-transmitting insects. Many wetlands were drained and filled in for cropping, pasturing, or even residential development. In the last few decades, however, the importance of wetlands has become evident, even as wetlands continue to decline in acreage.

Wetlands play an important role in maintaining water quality by trapping many pollutants in runoff and flood waters, thus often helping keep clean the water they connect to. They serve as buffers to catch and control what would otherwise be uncontrolled water and pollutants. Wetlands also play an essential role in the aquatic food chain (thus affecting fishery and water recreation), as well as serving as spaces for wildlife habitat, wildlife reproduction and nesting, and wildlife food.

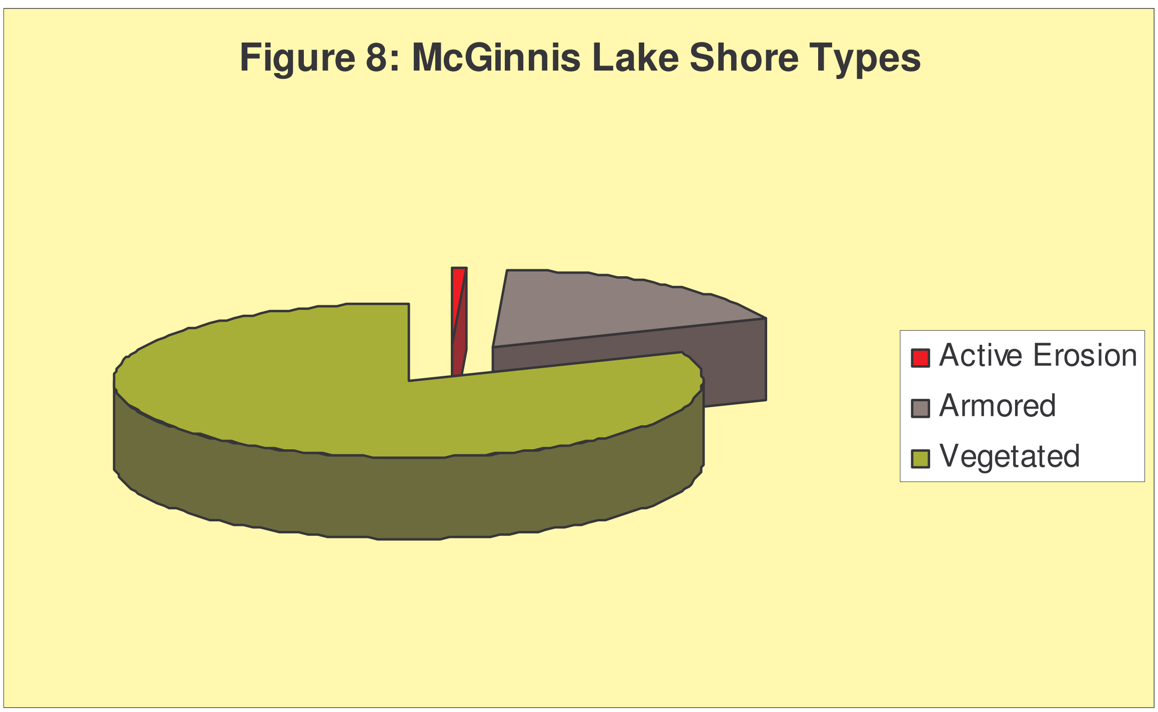
The areas of wetlands around McGinnis Lake serve as filters and traps. These are especially important because of the already increased loading discussed in the 2003 report. It is essential to preserve these wetlands for the health of McGinnis Lake.

Figure 7: Wetland Area at McGinnis Lake

SHORELANDS

McGinnis Lake has a total shoreline of 1.4 miles (7392 feet). The entire shore of the lakeshore is in residential use. Some of the areas at the northwest of the lake (deep lobe) are steeply sloped; the land is flatter on most of the lake. Several buildings on the east lobe of the lake are located fairly closely to the lake; buildings on the north lobe tend to be further back from the shore.

Less than half (46.4%) of McGinnis Lake's shoreline is vegetated with native vegetation. A 2004 shore survey showed that a small portion of the shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with mowed lawns, rock or hard structures and /or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.

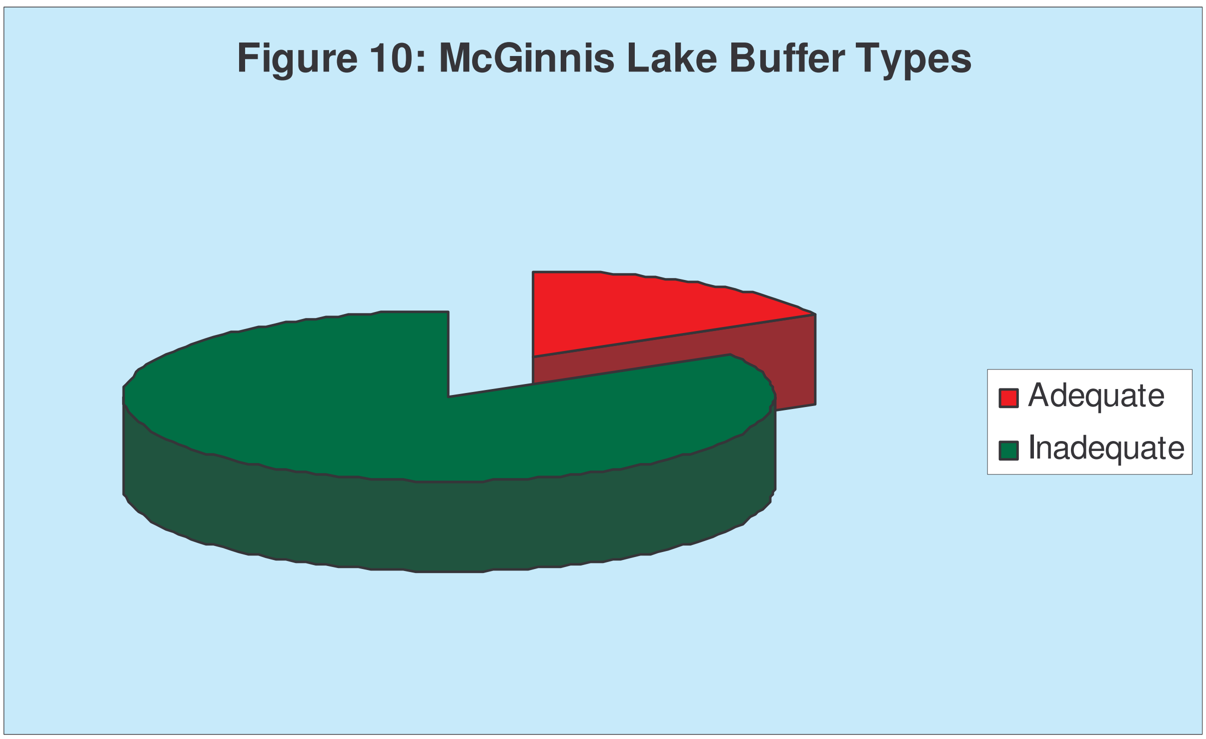


McGinnis Lake Shore Map

RE:2004

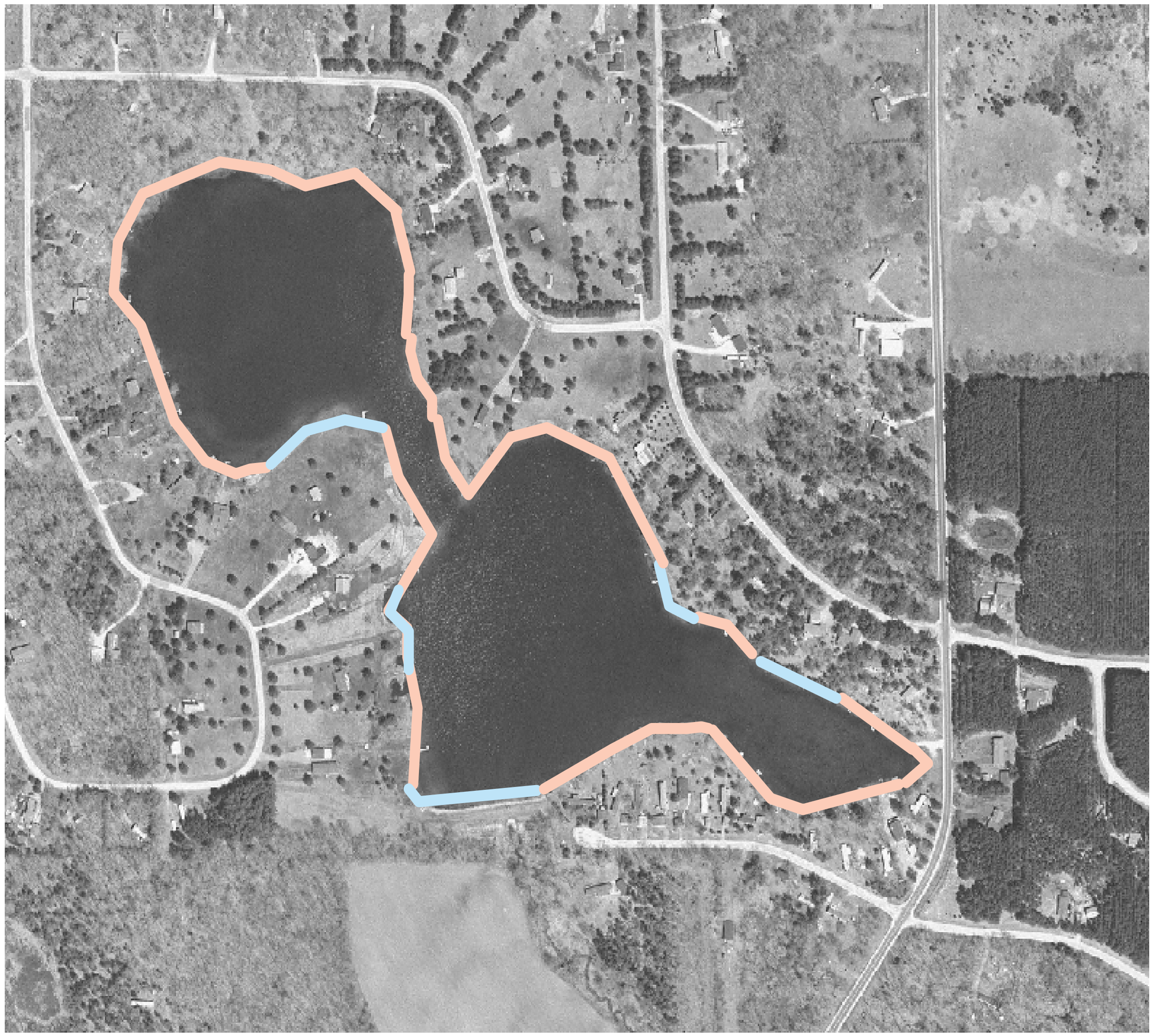
Figure 9: Shoreland Map of McGinnis Lake (2004)

The Adams County Shoreline Ordinance defines 1000' landward from the ordinary high water mark as "shoreland". Under the ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.



Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are some of McGinnis Lake shores. Figure 11 maps the adequate and inadequate buffers on McGinnis Lake.

Buffers on McGinnis Lake



RE:2004

Figure 11: McGinnis Lake Buffer Map (2004)

Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

When the natural shoreline is replaced by traditional mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils will be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Figure 12: Example of Inadequate Vegetative Buffer

Figure 13: Example of Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesthetics. Studies have shown that aesthetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on McGinnis Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Figure 14: Vegetated Buffer on McGinnis Lake

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information McGinnis Lake. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on the lake from the WDNR in a series of tests in 1992, from a lake study report published in 2003, and from Self-Help Monitoring records from 2002-2003.

Phosphorus

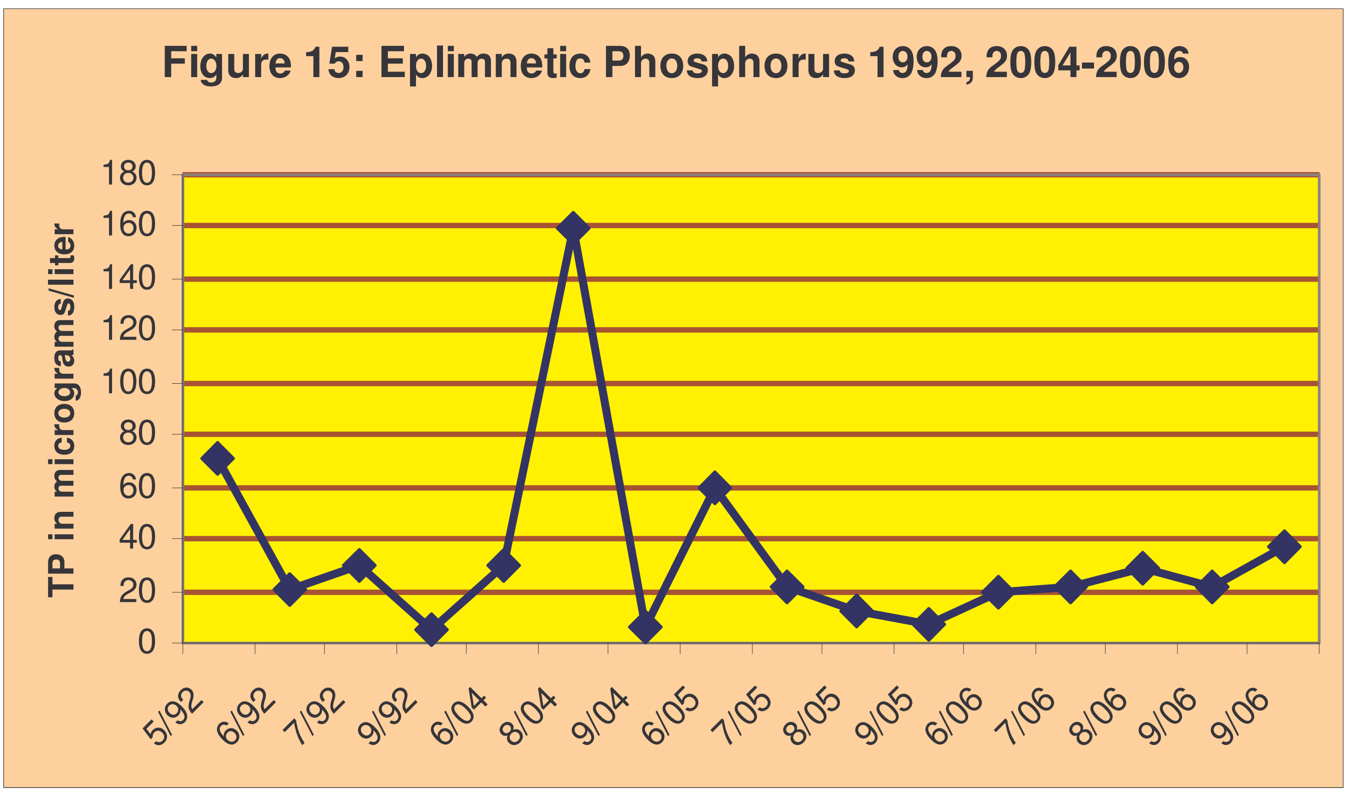
Most lakes in Wisconsin, including McGinnis Lake, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted), chemical reactions may cause phosphorus to be released to the water column.

Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For an impoundment lake like McGinnis Lake, a total phosphorus concentration below 30 micrograms/liter tends to prevent nuisance algal blooms. McGinnis Lake's growing season (June-September in 204-2006) surface average total phosphorus level of 28.91 micrograms/liter is slightly under to the level at which nuisance algal blooms can be expected. However, these readings were taken in the deep hole in the deeper lobe of the lake. The shallower end has frequent algal blooms, suggesting that total phosphorus readings in that part of the lake may be higher than those in the deep hole.

Since phosphorus is usually the limited factor, measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth.

The 2004-2006 summer average phosphorus concentration in McGinnis Lake places McGinnis Lake in the "good" water quality section for impoundments. Except for a spike in 2004, McGinnis Lake's epilimnetic total phosphorus readings have stayed fairly steady. It should be noted, however, that the total phosphorus reading in the bottom layers of the water averaged 62.62 micrograms/liter, more than twice as much as the upper layer average of 34.56 micrograms/liter since 1992. As the earlier reports suggested, phosphorus appears to be accumulating in McGinnis Lake, at least in the lower levels. Continued monitoring of both levels is suggested.



Groundwater testing of various wells around McGinnis Lake was done by Adams County LWCD and included a test one year for total phosphorus levels in the groundwater coming into the lake. The average TP level in the wells tested was of 14.25 micrograms/liter, considerably lower than the lake surface water results. Even if some of this phosphorus from the wells enters the lake from groundwater, it is unlikely to contribute significantly to the in-lake phosphorus levels.

Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. The land uses that contribute the most phosphorus are non-irrigated agriculture and residences. Using the current land use data, as well as phosphorus readings from 2004 through 2006 water sampling, a phosphorus loading prediction model was run for McGinnis Lake. The current results are shown in Figure 16.

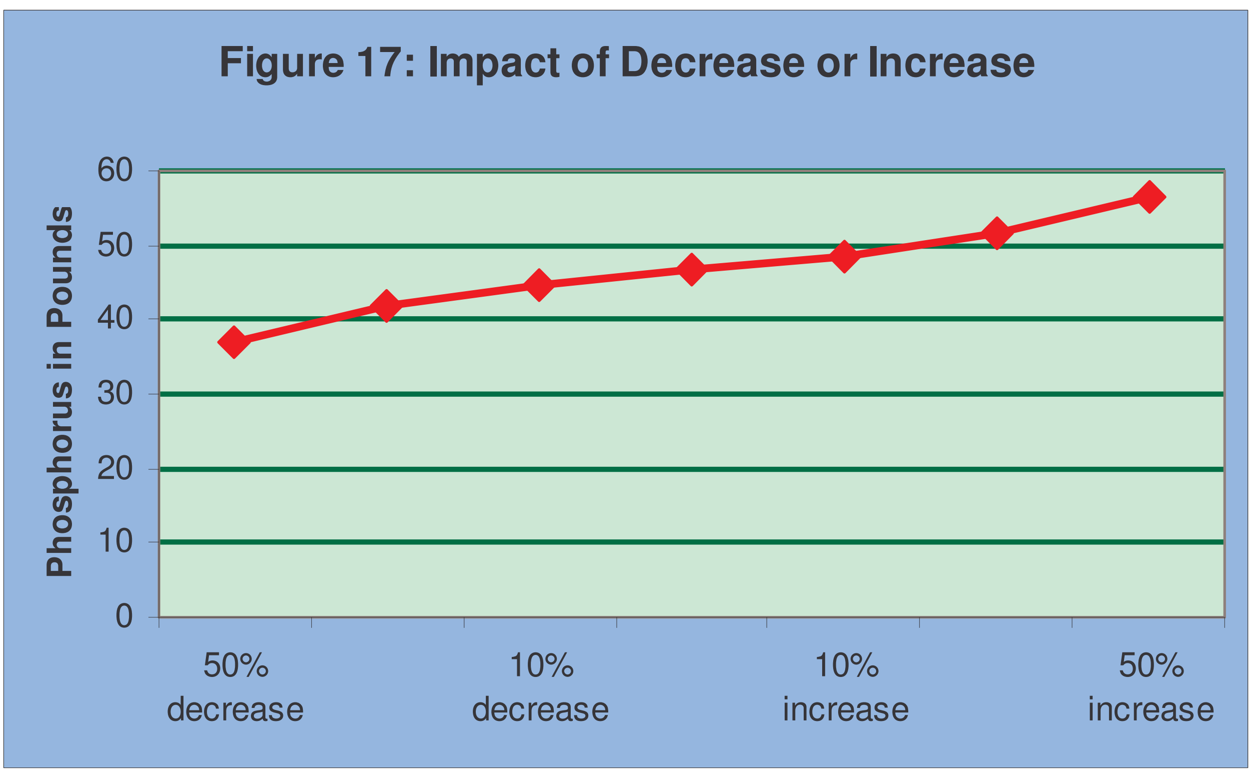
Figure 16: Current Phosphorus Loading by Land Use

MOST LIKELY ANNUAL PHOSPHORUS LOADING--CURRENT		
	% Loading	**Lbs/Acre/Yr**
Non-Irrigated Agriculture	1.9%	0.89
Residential	5.4%	1.78
Woodlands	2.3%	0.89
Ground Watershed	61.3%	28.55
Lake Surface	3.8%	1.78
Septics	25.3%	11.78
Total Phosphorus Load	100.0%	46.67

Currently, the most phosphorus loading is coming from the ground watershed, which includes many agricultural areas. The second largest estimated load is from septic systems. When the same model was run in the earlier 2000s, the ground watershed and in-lake loading (which would include septics) were determined to be the largest sources of phosphorus loading in the lake.

Although phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans, phosphorus loads from human activities such as agriculture, residential development and septic systems can be partly controlled by changes in human land use patterns. Practices such as agricultural buffers, nutrient management, shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the volume of phosphorus entering the lake. Many of these practices can also increase the concentration of phosphorus entering the lake, by runoff or other methods of entry.

The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. Just a 10% reduction of the human-impacted phosphorus would reduce the overall load by 1.99 pounds/acre/year. This figure may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in up to 995 pounds less of algae per acre per year!



Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve McGinnis Lake water quality by .7 to 16 micrograms. A 25% reduction would save 1.75 to 40 micrograms/liter and reduce the overall eplimnetic growing season total phosphorus to 26.7 micrograms/liter. Such decreases would make the deep hole total phosphorus levels considerably under the 30 micrograms/liter recommended to avoid nuisance and might also reduce the levels in the shallower end and result in fewer algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect McGinnis Lake's health for future generations.

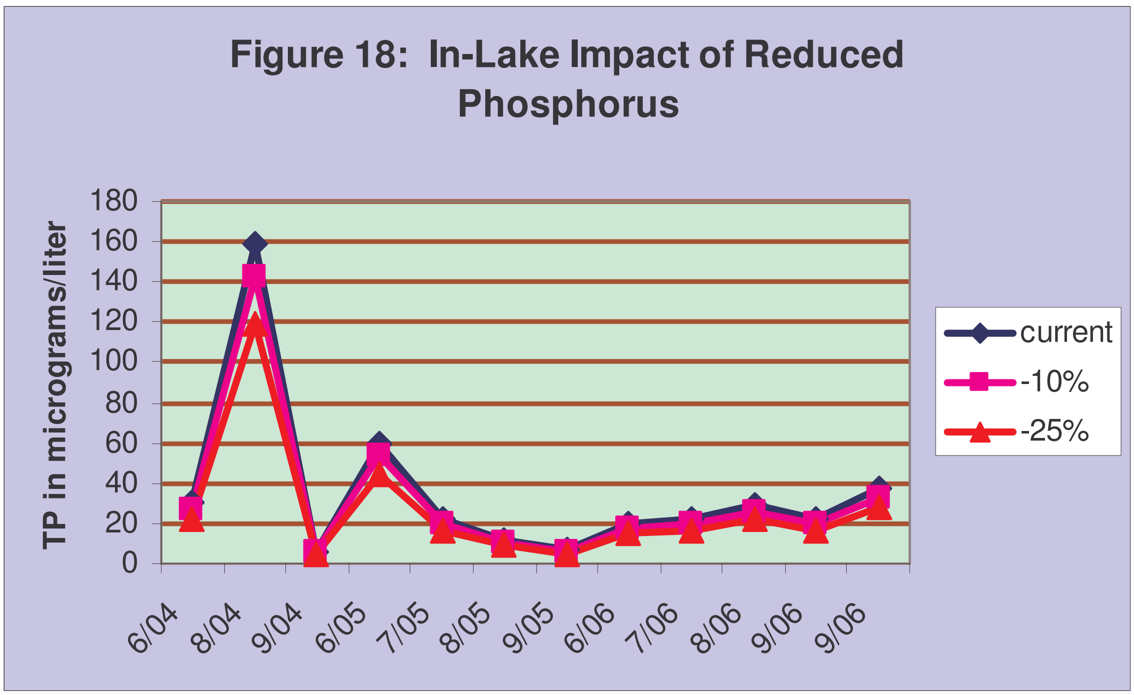
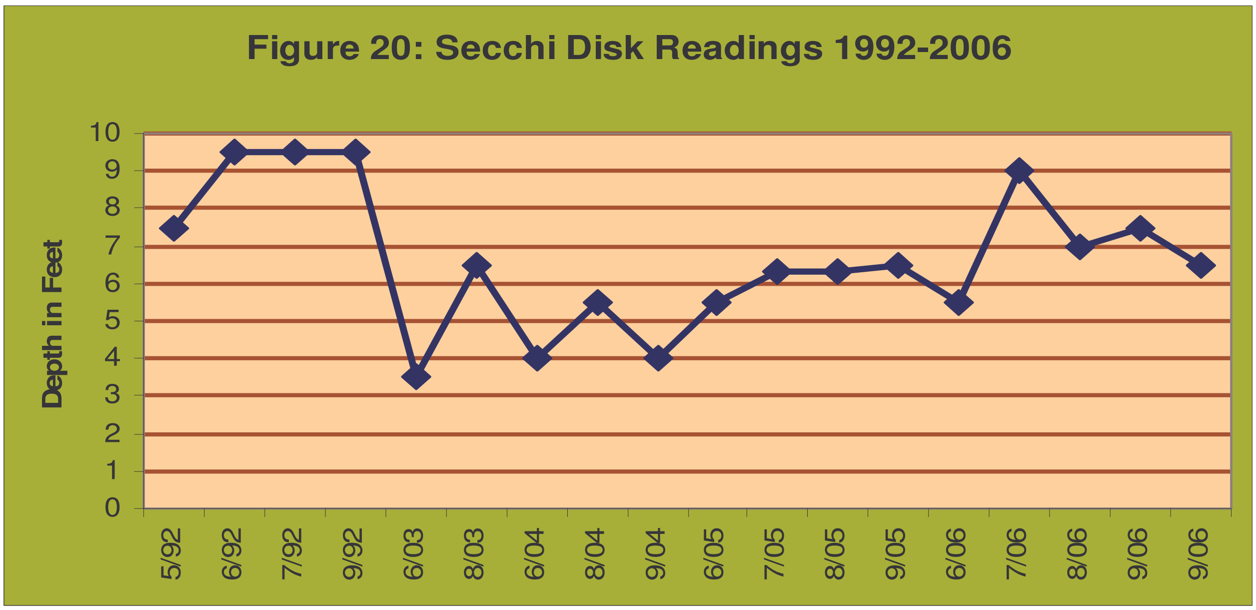


Figure19: Photo of a Lake in Algal Bloom

Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in McGinnis Lake in 2004-2006 was 5.91 feet. This is fair water clarity, putting McGinnis Lake into the "mesotrophic" category for water clarity.



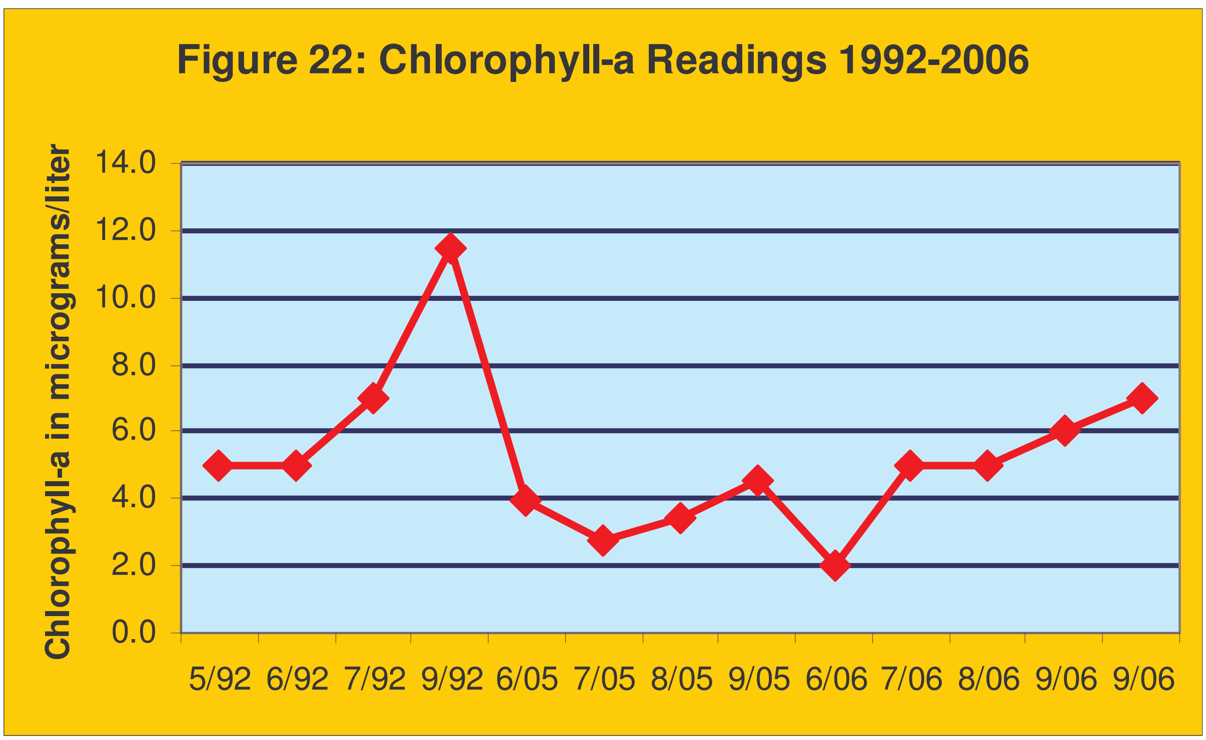
As is shown on the graph (Figure 20), the average Secchi disk reading in 1992 was 9 feet. But the growing season average for 2004-2006 was only 6.13 feet, a significant drop. The 2003 report suggested that suspended solids and algae in the McGinnis Lake water columns had increased, leading to reduced Secchi disk readings. This issue should be explored further by renewed and regular depth monitoring.

Figure 21: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 growing season (June-September) average chlorophyll concentration in McGinnis Lake was 2.3 micrograms/liter. Such an algae concentration places McGinnis Lake at the "very good" level for chlorophyll a results.

Chlorophyll-a averages varied considerably during the summers of 2004-2006. In 2006, summer temperatures were very elevated, which might have been a factor of the increased chlorophyll-a levels then, as plants slowed down photosynthesis due to the much hotter water (Figure 22).



Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants. During the summers of 2002, 2003, 2004 and 2005, dissolved oxygen levels in the lower depths of McGinnis Lake were very low, in the anoxic (no oxygen) to hypoxic (low oxygen) ranges.

Human activity can aggravate the development of low oxygen (hypoxic) or no oxygen (anoxic) in the bottom waters. For example, the addition of phosphorus usually leads to an increase in the growth of algae and aquatic plants—both of which consume oxygen during their photosynthesis. It has also been hypothesized that hypoxia or anoxia can be affected by climate changes, such as a longer and/or warmer summer, low lake levels, and changes in water temperature due to cover (i.e., shore vegetation) being removed.

The development of hypoxia or anoxia can have negative effects. The first effect usually noticed by human is fish kills. Fish kills result when fish species that need cold oxygen-rich water to survive can't find it in the lake anymore or when some of their invertebrate food (such as mayfly nymphs) is gone due to low oxygen levels. Another noticeable effect can be an increase in the frequency and distribution of algal blooms. In some instances, anoxia can lead to blooms of toxic algae and the production of water-borne toxins that can harm humans and wildlife. Anoxia sometimes also leads to increased phosphorus cycling, undesirable water taste or odor levels, and interference with recreational uses such as swimming, boating and fishing.

As noted above, summer hypoxia or anoxia can result in phosphorus being released into the upper water column and being available for algal blooms and increased aquatic plant growth. This data shows that there is potential for phosphorus loading from the lower depths (hypolimnion) during the summer months in McGinnis Lake if the hypoxia/anoxia continues. Dissolved oxygen needs to be monitored during the late summer months in the lower depths on McGinnis Lake to determine whether hypoxia/anoxia is a frequently-occurring condition that may need to be addressed by management practices.

Figure 23a: Dissolved Oxygen Levels2002-2003-2003 in milligrams/liter

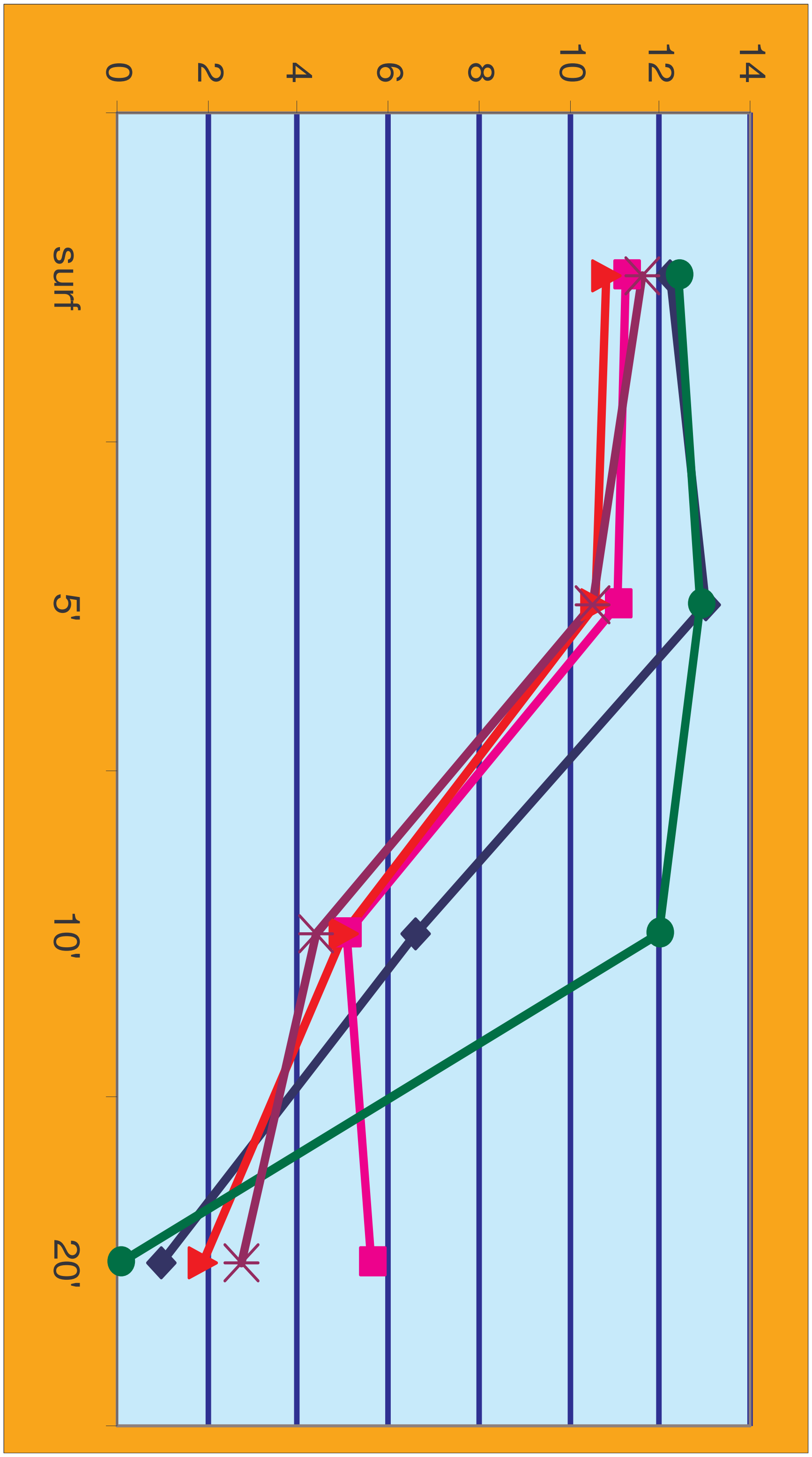


Figure 23b: Dissolved Oxygen Levels During 2004 Water Testing in milligrams/liter

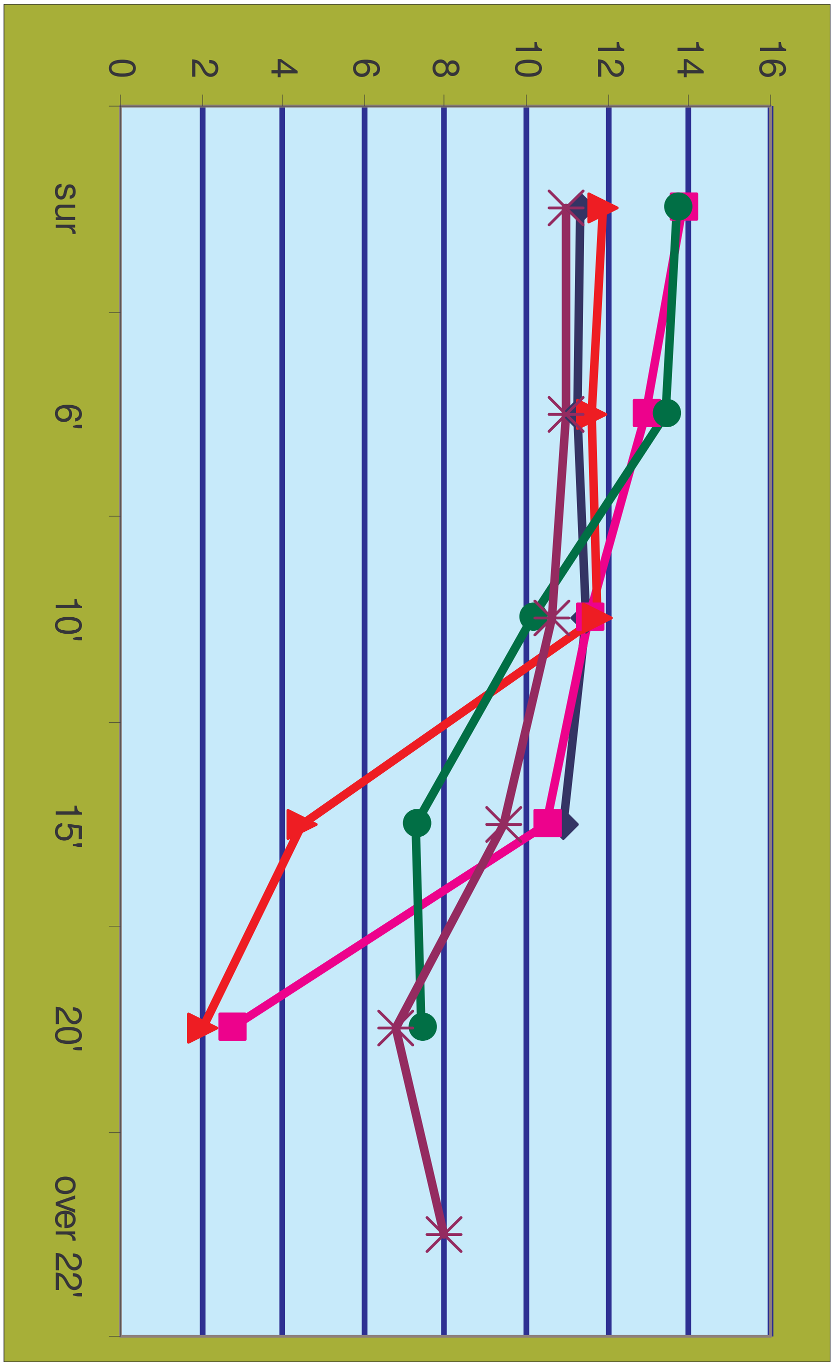


Figure 23c: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter

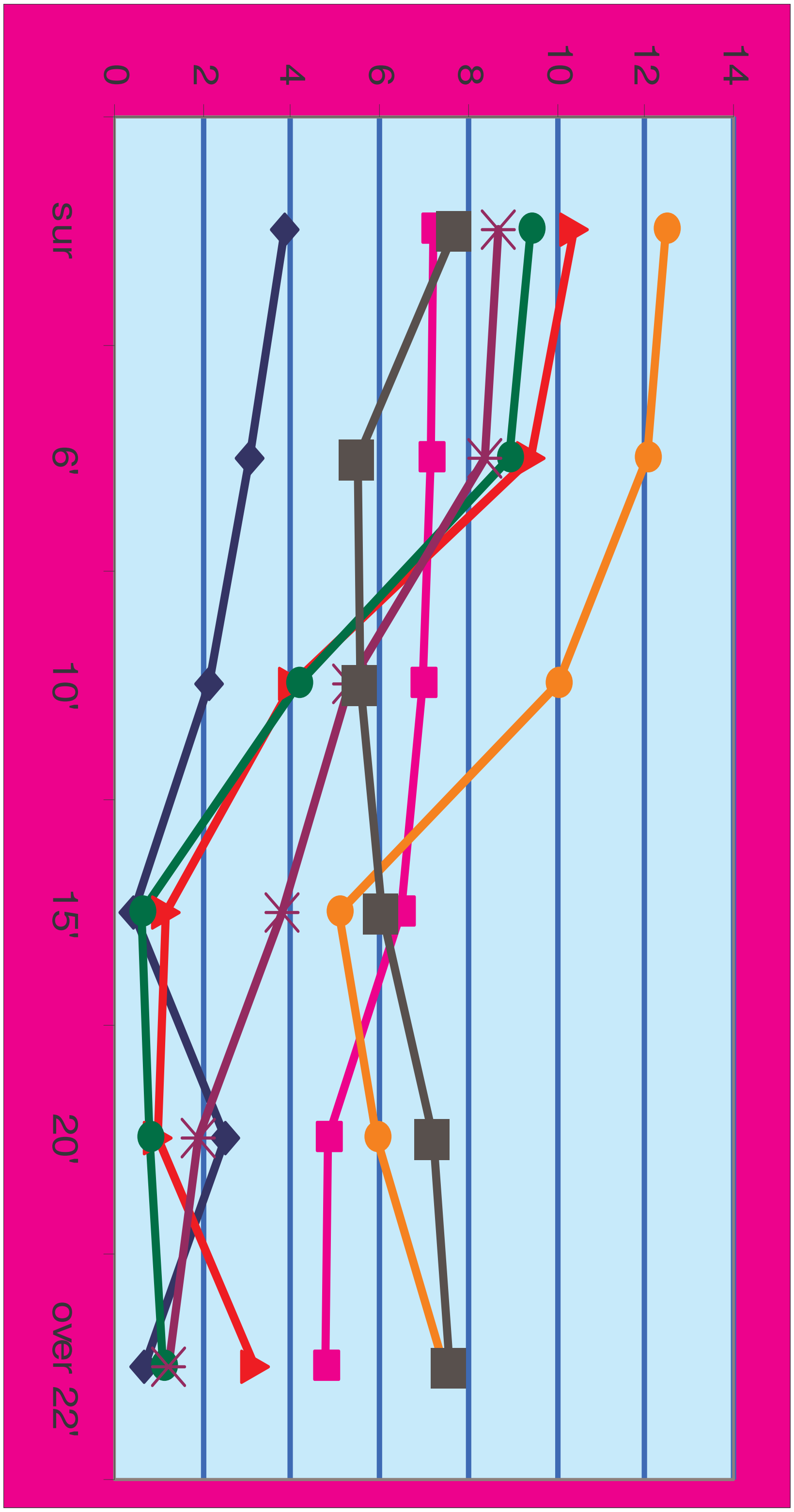
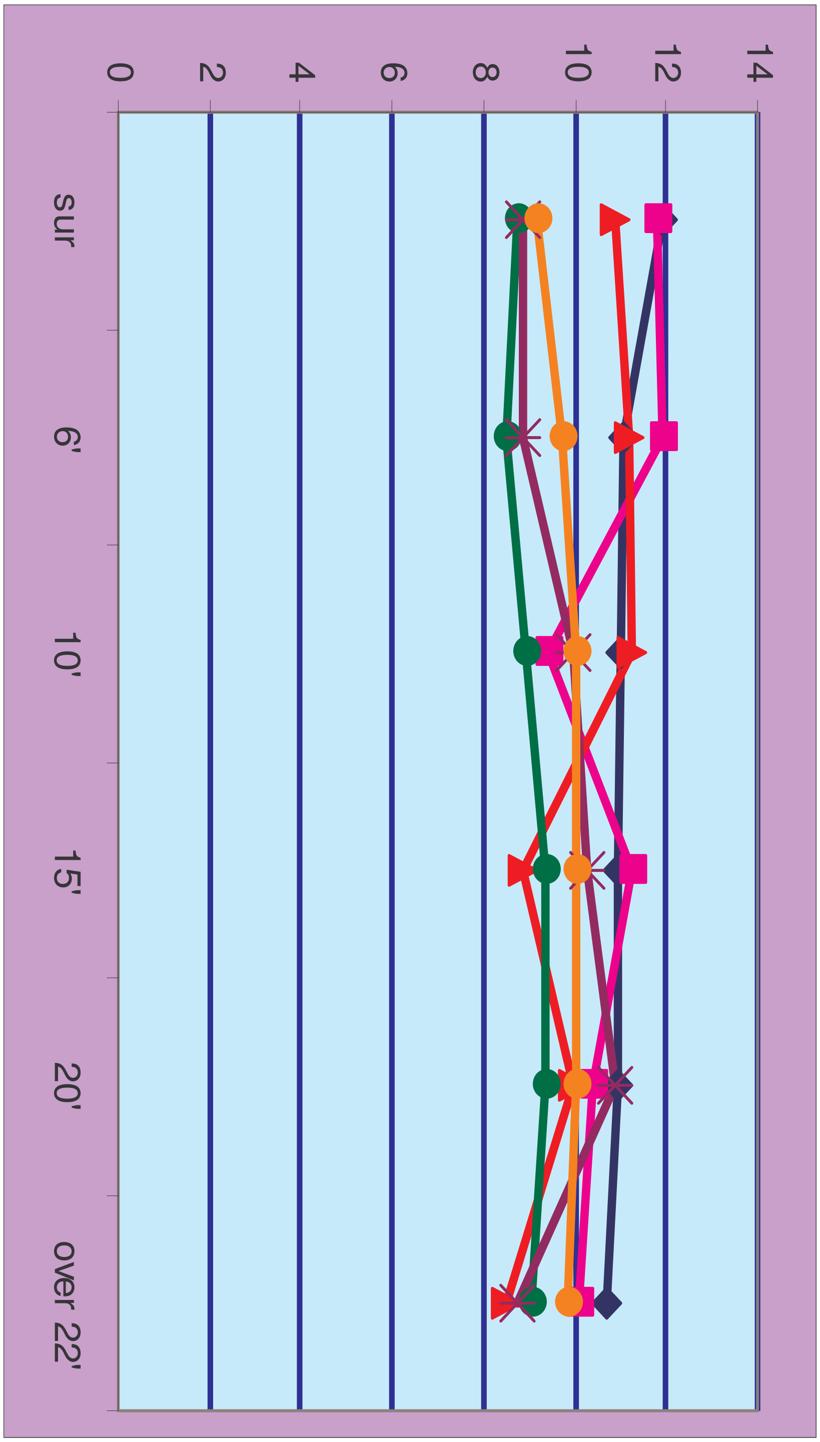
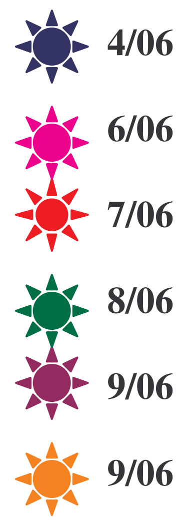


Figure 23d: Dissolved Oxygen Levels During 2006 Water Testing in milligrams/liter





Water Hardness, Alkalinity and pH

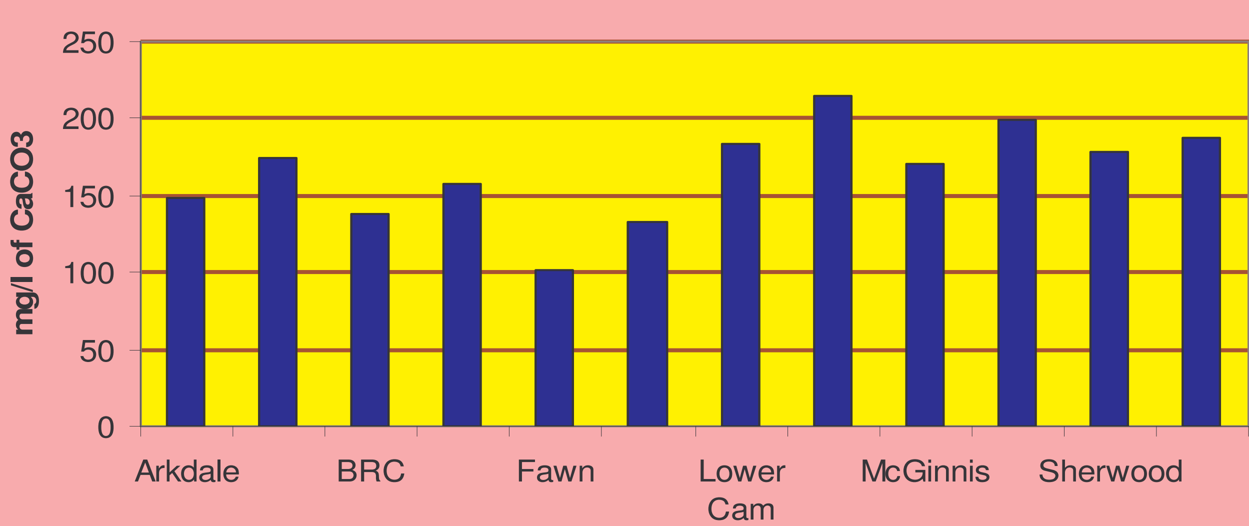
Testing done by Adams County LWCD on McGinnis Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Milligrams/liter CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 24: Hardness Table

One method of evaluating hardness is to test the water for the amount of calcium carbonate ($CaCO_3$) it contains. The surface water of all of the public access lakes in Adams County have water that is moderately hard to very hard, whether they are impoundments (man-made lakes) or natural lakes. In 2005 and 2006, random samples were also taken of wells around McGinnis Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater ranged from 120 (moderately hard) to 242 (very hard), with an average of 200 milligrams/liter. This is slightly higher than the surface water average hardness of 171.67 milligrams/liter of calcium carbonate. The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.

Figure 25: Hardness in Adams County Impoundments



As the graph (Figure 25) shows, McGinnis Lake surface water testing results showed "very hard" water (average 171.67 milligrams/liter CaCO3), higher than the overall hardness average impoundments in Adams County of 166 milligrams/liter of Calcium Carbonate. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

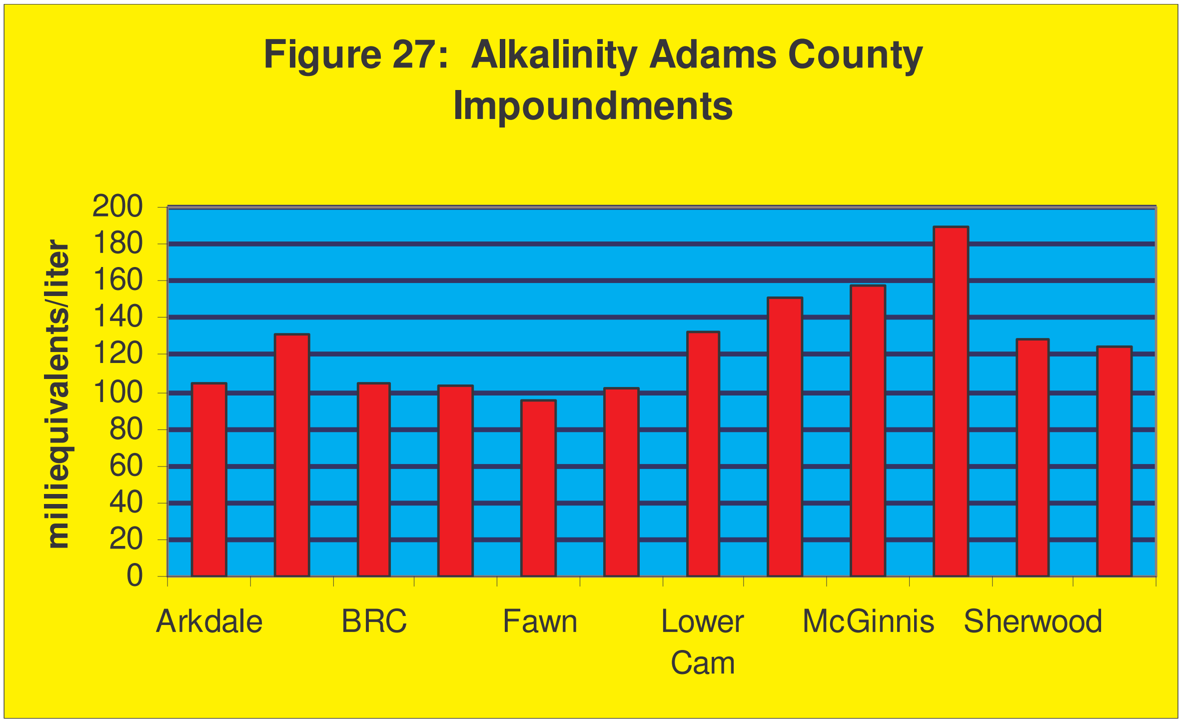
Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

Figure 26: Acid Rain Sensitivity

Well water testing results averaged 156.89 milliequivalents/liter, ranging from 116 milliequavalents/liter to 196 milliequivalents/liter in alkalinity. This is about the same the surface water average of 156 milliequivalents/ liter. McGinnisLake's potential sensitivity to acid rain is moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.



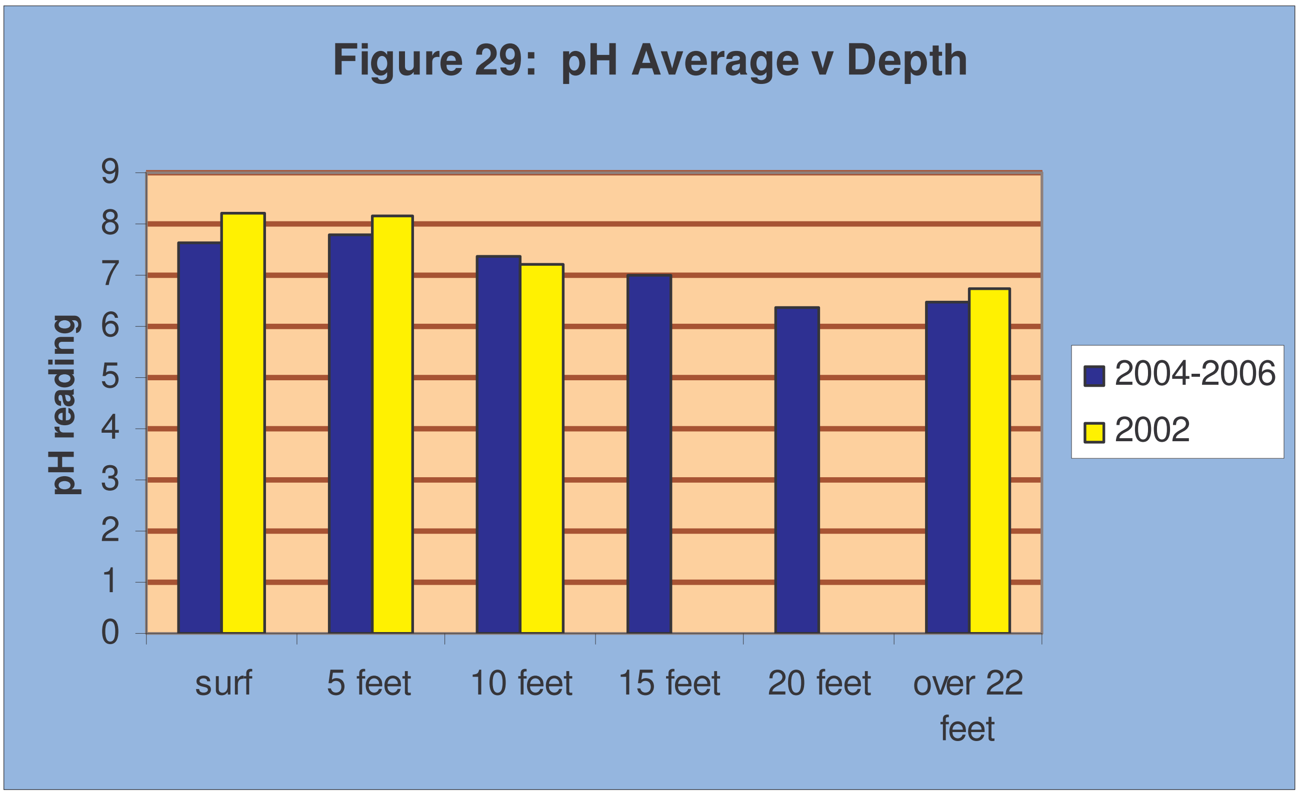
The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in McGinnis Lake. As is common in the lakes in Adams County, McGinnis Lake has pH levels starting at just under neutral (6.5) at 22+ feet depth and increasing in alkalinity as the depth gets less, until the surface water pH averages 7.63. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.

More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 28):

Figure 28: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

No pH levels taken in McGinnis Lake between 2004-2006 fell below the pH level that inhibits walleye reproduction. A lake with a neutral or slightly alkaline pH like Big McGinnis Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at McGinnis Lake. McGinnis Lake has a good pH level for fish reproduction and survival.



Other Water Quality Testing Results

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level found in McGinnis Lake during the testing period was 1.36 milligrams/liter, not elevated substantially above the natural level of chloride in this area of Wisconsin of 3 milligrams/liter. However, because the report published in 2003 indicated higher levels of chloride had been found, further investigation as to the cause of such elevations and continued monitoring need to be performed.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). McGinnis Lake combination spring levels from 2004 to 2006 averaged 0.11 milligrams/liter, considerably below the .3 milligrams/liter predictive level for nitrogen-related algal blooms. These elevations suggest that some of the algal blooms on McGinnis Lake are probably not nitrogen-related.

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 milligrams/liter may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from calcium and magnesium. The average Calcium level in McGinnis Lake's water during the testing period was 32.06 milligrams/liter. The average Magnesium level was 19.42 milligrams/liter. Both of these are low-level readings.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. The level of these two is generally not useful as a specific pollution indicator, but increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Some health professionals have suggested that sodium levels over 20 milligrams/liter may be harmful to heart and kidney patients if ingested. Both sodium and potassium levels in McGinnis Lake are very low: the average sodium level was 1.76 milligrams/liter; the average potassium reading 0.58 milligrams/liter.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. McGinnis Lake sulfate levels averaged 8.91 milligrams/liter during the testing period, below both the level for hydrogen sulfate formation and the health advisory level.

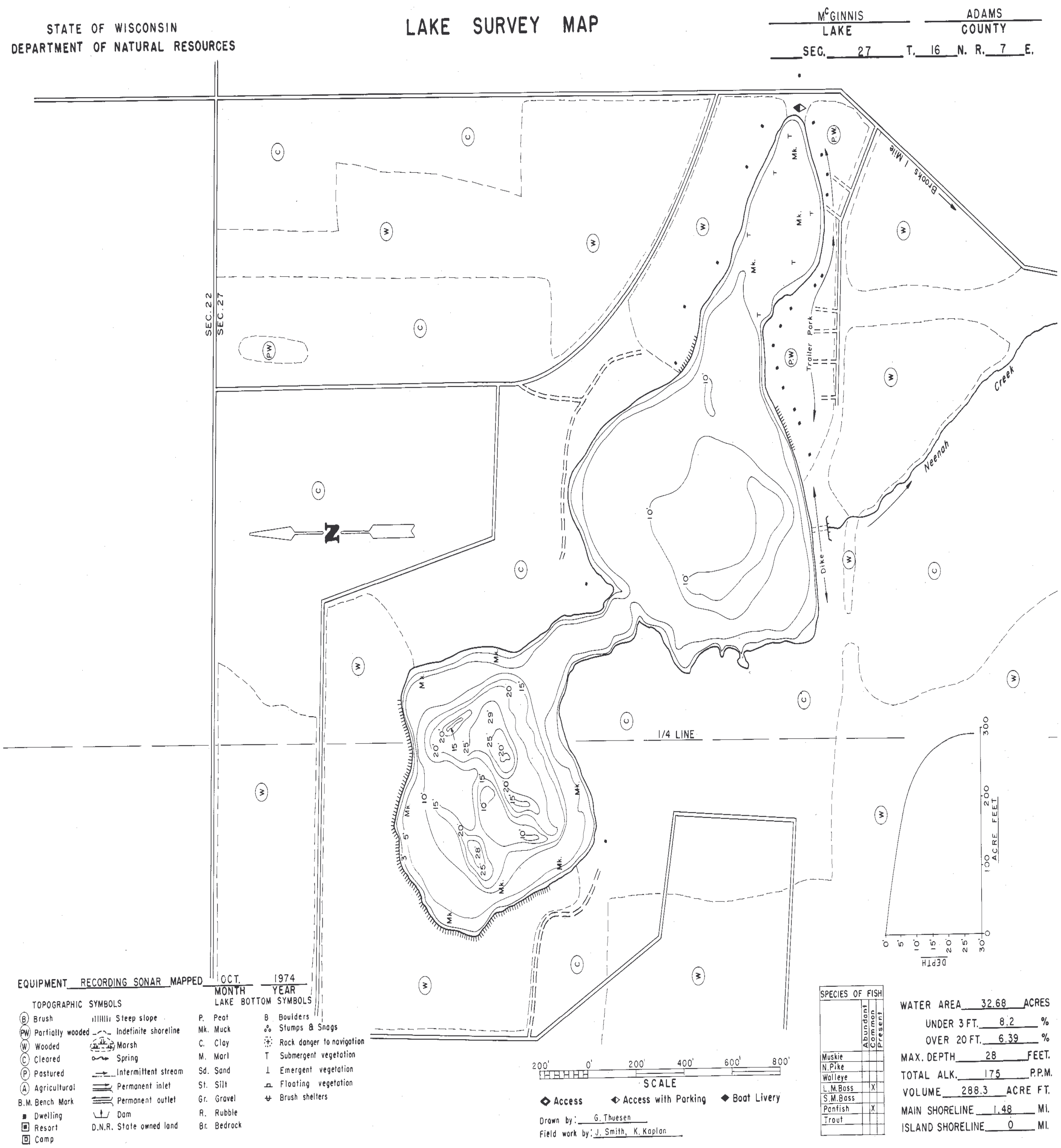
TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Big McGinnis Lake's waters were at moderate levels during the 2004-2006 testing period: 3.56 NTU in 2004, 3.03 NTU in 2005 and 3.14 NTU in 2006.

Figure 30: Examples of Very Turbid Water

HYDROLOGIC BUDGET

According to date in a 1978 WDNR bathymetric (depth) map, McGinnis Lake had 32.68 surface acres, and the volume of the lake is 288.32 acre-feet. At that time, 8.2% of the lake was less than 3 feet deep and 6.39% was over 20 feet deep. The maximum depth was 28 feet.

Figure 31: Bathymetric Map of McGinnis Lake

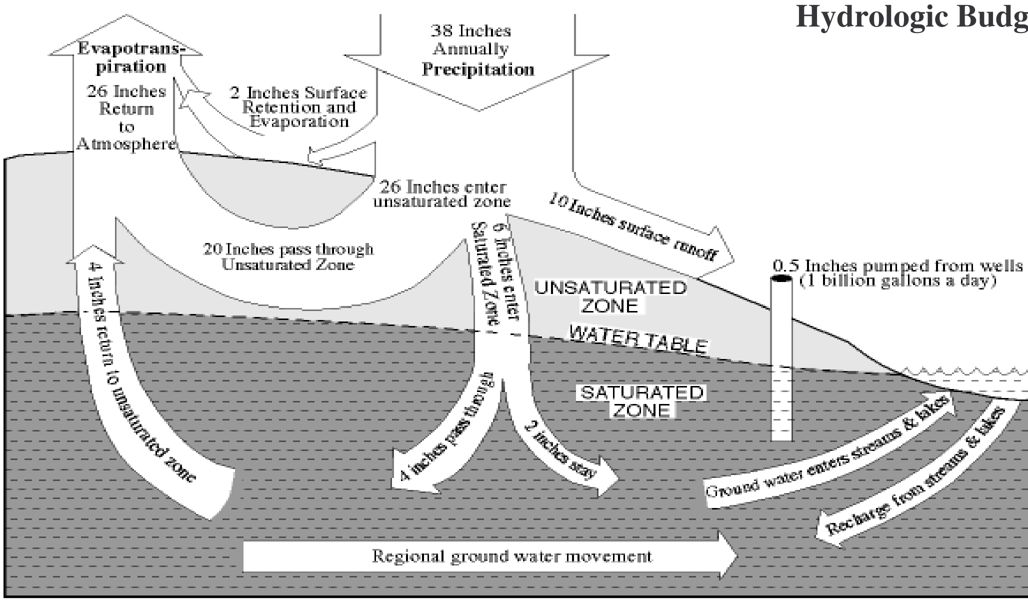


A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. "Flushing rate" is the time it takes a lake's volume to be replaced. "Annual runoff volume", as used in WiLMS, is the total water yield from the drainage area reaching the lake. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for McGinnis Lake as 1896.6 acres. The average unit runoff for Adams County in the McGinnis Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 1485.7 acre-feet/year. Anticipated annual hydraulic loading is 1482.8 acre-feet/year. Areal water load is 45.7 feet/year.

In an impoundment lake like McGinnis Lake, flushing rates and residence rates are generally less than they would be in land-locked natural lake. McGinnis Lake's case, modeling estimates a water residence of 0.12/year. The calculated lake flushing rate is 8.46 1/year. Water and its load flow through McGinnis Lake fairly quickly.

Figure 32: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (see Figure 33). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of McGinnis Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for McGinnis Lake would be **48**. This score places McGinnis Lake's overall TSI at below the average for impoundment lakes in Adams County (52.83)—which is a good thing in the TSI calculations, where the lower the score, the better.

Figure 33: Trophic Status Table

McGinnis Lake = 48

Score	**TSI Level Description**
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

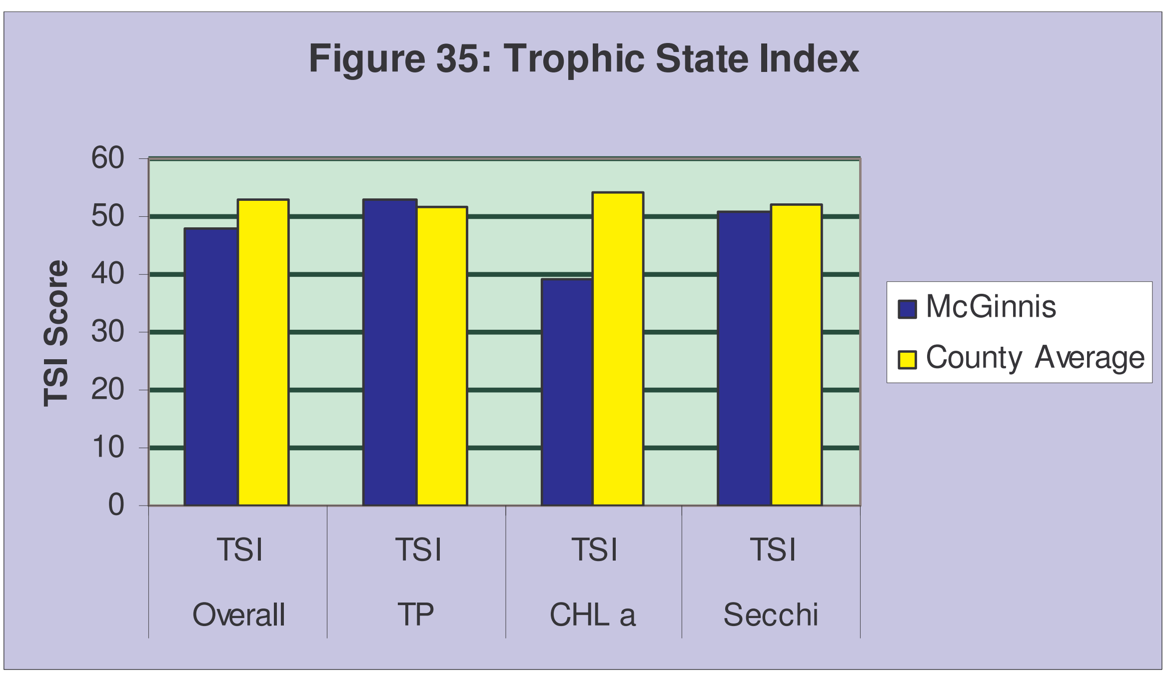
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average growing season epilimnetic total phosphorus for McGinnis Lake was 23.91

micrograms/liter. The average growing season chlorophyll-a concentration was 2.3 micrograms/liter. Growing season water clarity averaged a depth of 5.91 feet. Figure 39 shows where each of these measurements from McGinnis Lake fall in trophic level.

Figure 34: McGinnis Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(ug/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	**1 to 5**	8 to 19
Mesotrophic	Good	**10 to 30**	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	**5 to 6**
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
McGinnis Lake		**28.91**	**2.3**	**5.91**

These figures show that McGinnis Lake has good to very good levels overall for the three parameters often used to described water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

The first recorded aquatic plant survey was by DNR staff in 1963. This qualitative survey showed that the plant-like algae, *Chara spp*, abundant, as was *Ceratophyllum demersum* (coontail). Water milfoil was also abundant; smartweed was common. Pondweeds were scarce, as was filamentous algae. A limited survey was done by UWSP students for *Potamogeton crispus* (Curly-Leaf Pondweed) in 2002. In 2004, a sensitive area study was done on McGinnis Lake. Aquatic vegetation found included *Ascelpias incarnata, Calamagrostis canadensis, Ceratophyllum demersum, Chara spp, Cicuta bulbifera, Iris versicolor, Myriophyllum sibiricum, Najas flexilis, Potamogeton crispus, Potamogeton illinoensis, Potamogeton pectinatus, Potamogeton richardsonii, Ranunculus longirostris, Rumex spp, Salix spp, Scirpus validus* and *Typha latifolia.* Substantial filamentous algae were also noted.

Another aquatic macrophyte (plant) field study of McGinnis Lake was conducted during June 2006 by a staff member of the Wisconsin Department of Natural Resources and a staff member of the Adams County Land and Water Conservatism Department.

Of the 39 species found in McGinnis Lake in 2006, 37 were native and 2 were exotic invasives. In the native plant category, 23 were emergent, 3 were free-floating plants, 1 was a floating-leaf rooted type, and 10 were submergent types. Two exotic invasives, *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton crispus* (Curly-Leaf Pondweed, were found.

Traditional cultivated lawn was the shoreline cover with highest percent cover (36.67%). Other disturbed sites, such as those with rock/riprap and hard structures (such as piers) covered another 9% of the shoreline. Some type of native vegetated shoreline was found at 100.00% of the sites and covered 54.34% of the lake shoreline.

Figure 36. McGinnis Lake Aquatic Plant Species, 2006

Scientific Name	Common Name	Type
Asclepias incaranata	Swamp Milkweed	Emergent
Calamagrostis canadensis	Blue-Joint Grass	Emergent
Carex aquatilis	Water Sedge	Emergent
Carex bebbii	Bebb's Sedge	Emergent
Carex echinata	Star Sedge	Emergent
Carex hystericina	Bottlebrush Sedge	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara spp	Muskgrass	Submergent
Cicuta bulbifera	Water Hemlock	Emergent
Cicuta maculata	Spotted Water Hemlock	Emergent
Elocharis acicularis	Needle Spikerush	Emergent
Elodea canadensis	Waterweed	Submergent
Eupatorium maculatum	Spotted Joe Pye Weed	Emergent
Impatiens capensis	Jewelweed	Emergent
Iris versicolor	Blue-Flag Iris	Emergent
Juncus effusus	Common Rush	Emergent
Lemna minor	Lesser Duckweed	Free-Floating
Lysimachia quadriflora	4-Flowered Yellow Loosestrife	Emergent
Myriophyllum sibiricum	Northern Milfoil	Submergent
Najas flexilis	Bushy Pondweed	Submergent
Onoclea sensibilis	Sensitive Fern	Emergent
Pedicularis canadensis	Wood Betony	Emergent
Phalaris arundinacea	Reed Canarygrass	Emergent
Polygonum amphibium	Water Smartweed	Floating-Leaf
Potamogeton amplifolius	Large-Leaf Pondweed	Submergent
Potamogeton crispus	Curly-Leaf Pondweed	Submergent
Potamogeton illinoensis	Illnois Pondweed	Submergent
Potamogeton pectinatus	Sago Pondweed	Submergent
Potamogeton praelongus	White-Stemmed Pondweed	Submergent
Potamogeton richardsonii	Clasping-Leaf Pondweed	Submergent
Rancunculus longirostris	Water Buttercup	Emergent
Rumex orbiculatus	Great Water Dock	Emergent
Salix amygdaloides	Peach-Leaf Willow	Emergent
Scirpus validus	Soft-Stem Bulrush	Emergent
Solanum ptycanthum	Nightshade	Emergent
Spirdoela polyrhiza	Greater Duckweed	Free-Floating
Thelypteris palustris	Marsh Fern	Emergent
Typha latifolia	Narrow-Leaf Cattail	Emergent
Wolffia columbiana	Watermeal	Free-Floating

Figure 37a: Emergent Plants in McGinnis Lake 2006

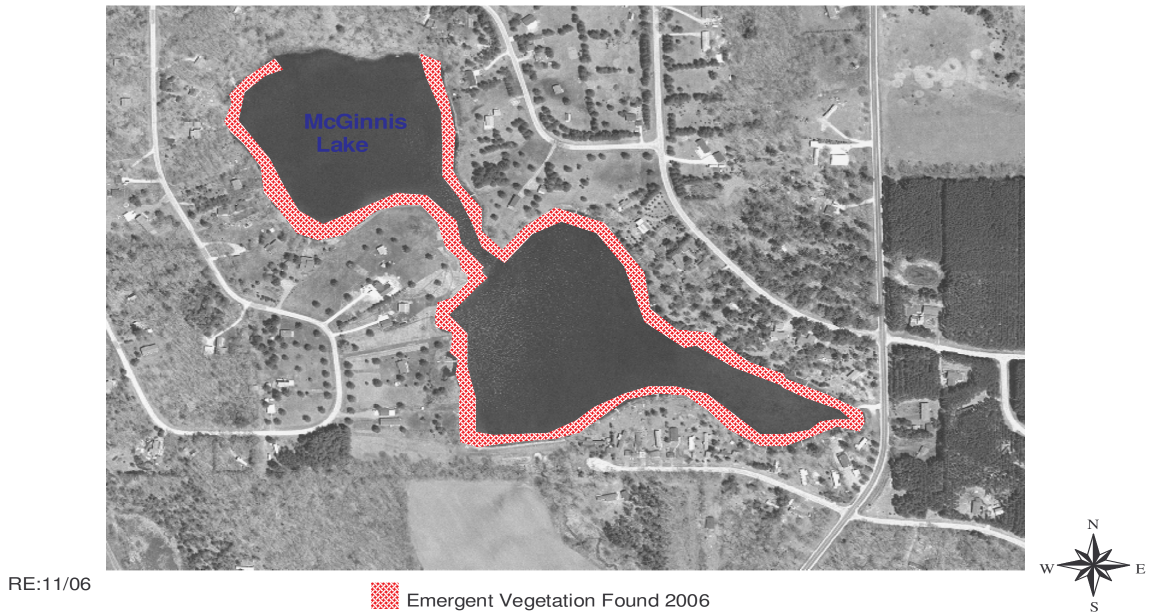


Figure 37b: Floating Plants in McGinnis Lake 2006

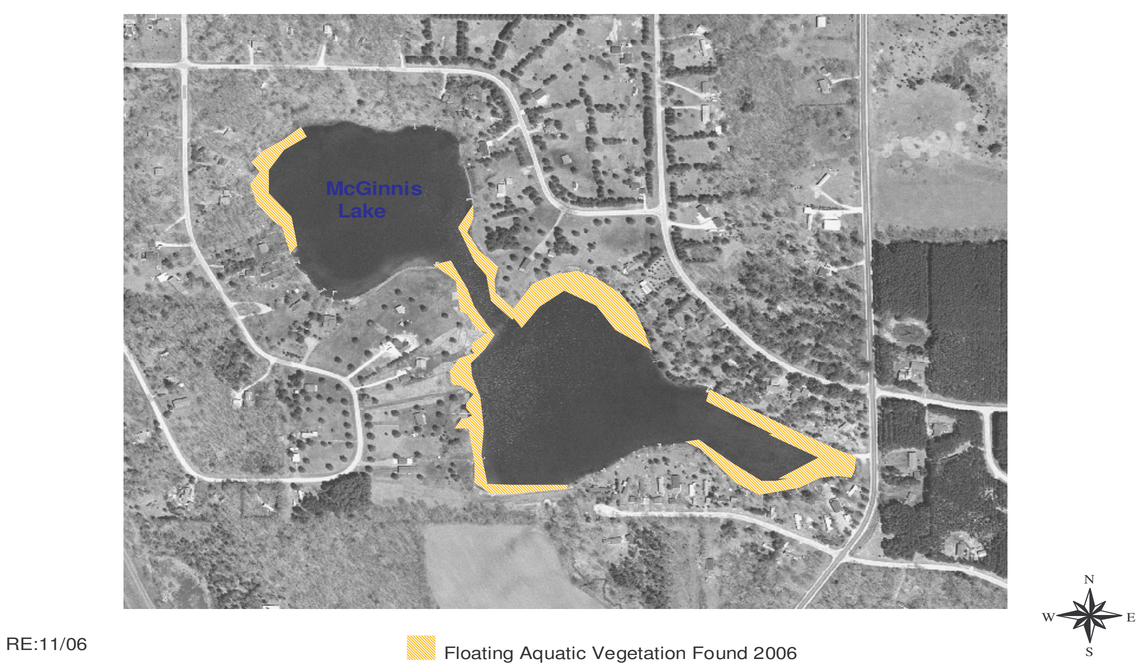
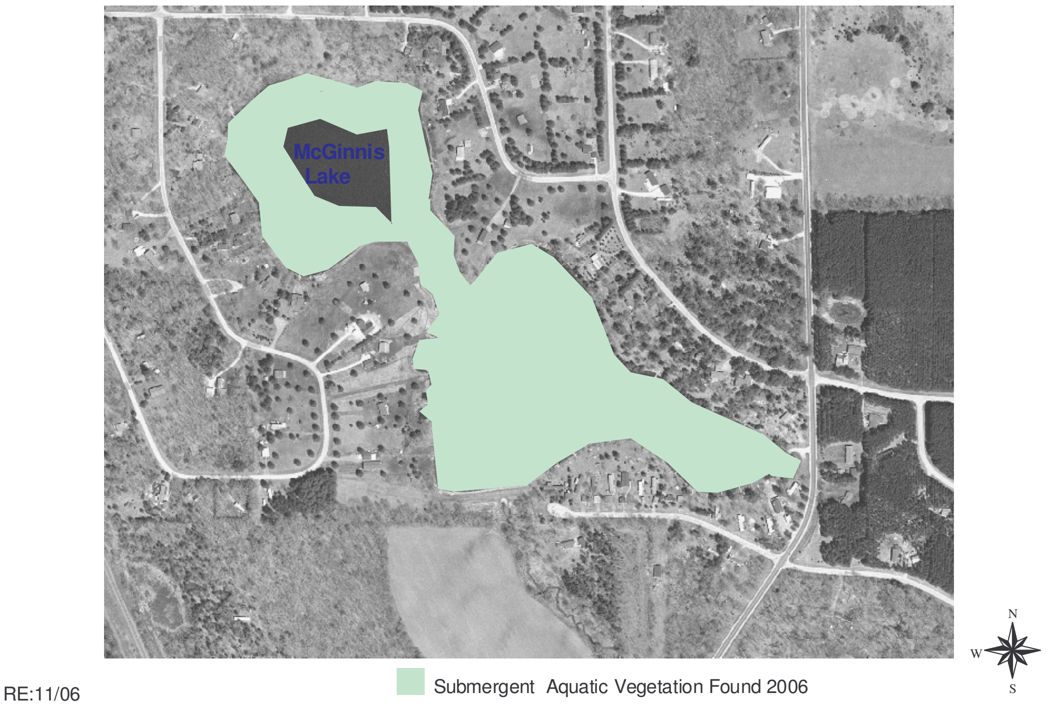


Figure 37c: Submergent Plants in McGinnis Lake 2006



The invasive aquatic plant, *Potamogeton crispus* (Curly-Leaf Pondweed) was the most frequently-occurring plant in McGinnis Lake in 2006, followed by the native aquatic plants, *Ceratophyllum demersum* (coontail), *Myriophyllum sibiricum* (northern watermilfoil) and *Potamogeton pectinatus* (Sago pondweed). No other species reached a frequency of 50% or greater. Filamentous algae were found at 86.27% of the sample sites.

Potamogeton crispus was also the densest plant in McGinnis Lake. Other dense plants were *Ceratophyllum demersus,*, *Myriophyllum sibiricum* and *Potamogeton pectinatus*. No aquatic plants occurred at greater than average density overall. However, in Depth Zone 2 (1.5 feet-5 feet), *Potamogeton pectinatus* and *Potamogeton crispus* occurred at more than average mean density. In Depth Zone 3 (5 feet-10 feet), *Myriophyllum sibiricum, Potamogeton crispus* and *Potamogeton pectinatus* all occurred at more than average density. *Ceratophyllum demersum* occurred at above average density in Depth Zone 4 (10 feet-20 feet).

Potamogeton crispus (the invasive exotic) was the dominant aquatic plant species in McGinnis Lake during early summer. Sub-dominant were *Ceratophyllum demersum, Myriophyllum sibiricum* and *Potamogeton pectinatus*. *Phalaris arundinacea*, the other exotic found at McGinnis Lake, was not present in high frequency, high density or high dominance.

Secchi disc readings are used to predict maximum rooting depth for plants in a lake (Dunst, 1982). Based on the summer 2004-2006 Secchi disc readings, the predicted maximum rooting depth in McGinnis Lake would be 10.2 feet. During the 2006 aquatic plant survey, rooted plants were found to a maximum depth of 19 feet, i.e., rooted plants were at a depth more to that to be expected by Dunst calculations.

The 0-1.5 feet depth zone (Zone 1) supported the greatest total occurrence and density of aquatic plant growth. The greatest number of species per site (species richness) was found in Zone 1 with 10.33 species richness. Overall lake species richness was 5.8.

The Simpson's Diversity Index for McGinnis Lake was 0.92, very good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places McGinnis Lake in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. The AMCI for McGinnis Lake is 56, placing it in the average range for North Central Wisconsin Lakes and all Wisconsin Lakes.

The presence of *Potamogeton crispus* is a significant factor in the future. Currently, it appears to be taking over the aquatic plant community. Its early growth and ability to spread quickly makes it a danger to the diversity and aquatic habitat of McGinnis Lake.

An Average Coefficient of Conservatism and a Floristic Quality Index calculation were performed on the field results. Technically, the Average Coefficient of Conservatism measures the community's sensitivity to disturbance, while the Floristic Quality Index measures the community's closeness to an undisturbed condition. Indirectly, they measure past and/or current disturbance to the particular community.

The Average Coefficient of Conservatism in McGinnis Lake in 2006 was 4.9. This puts it in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in McGinnis Lake is in the category of those very tolerant of disturbance, probably due to selection by a series of past disturbances, such as developed shorelines, boat traffic, and introduction of non-native species.

The Floristic Quality Index of the aquatic plant community in McGinnis Lake of 30.58 is above average for Wisconsin Lakes (22.2) and the North Central Hardwood Region (20.9). This suggests that the plant community in McGinnis Lake is closer to an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. This scale suggests that the aquatic plant community in McGinnis Lake has been impacted by less than average amount of disturbance.

Only about one-third of the sample transects had an entirely native shore; two-thirds of the sites had some disturbance by humans. 60% of the sites had disturbance amounts of over 50%. Aquatic plant data was divided into two categories, disturbed and natural. Calculations were then performed on each category as if it was a separate lake in order to determine what differences there were between the aquatic plant community at natural shores vs. disturbed shores.

Figure 38: Comparison of Natural & Disturbed Shores

	Natural	Disturbed
Number of species	26	36
FQI	26.08	29.83
Average Coef. Of Cons	5.12	4.97
Simpson's Index	0.91	.92
AMCI	58	54
Filamentous algae	100%	93.94%

Using these figures, the disturbed shore community actually had a higher score for Simpson's Index, FQI and species number, but the natural shore community had a higher coefficient of Conservatism and higher Aquatic Macrophyte Community Index. The high amount of disturbance in the lake overall probably explains this variety of differentiation between natural and disturbed shore communities.

Sufficient nutrients (trophic state), fair water clarity, shallow lake, soft sediments and increased shore development at McGinnis Lake favor plant growth. Despite the sometime limiting effect of sand sediments on aquatic plant growth, 89% of the lake is vegetated, suggesting that even the sand sediments in McGinnis Lake hold sufficient nutrients to maintain aquatic plant growth. This percent of plant cover is slightly over the recommended plant cover for a balanced fishery (50%-85%).

Figure 39: Sediment Map of McGinnis Lake

RE:11/06 Hard Sediments Mixed Sediments Soft Sediments

N W E S

All aquatic plant control methods in McGinnis Lake have been chemical. A continued regular schedule and pattern of machine harvesting could help in removing vegetation from the lake and may help with nutrient reduction. The harvesting should also be designed to set back the growth of Curly-Leaf Pondweed. It might also help to skim off the high density of filamentous algae and floating-leaf plants, especially in the shallower areas of the lake.

The first recorded chemical applications were in 1979, but specific chemicals, amount applied and acreage cover are not available in the records. No information is yet available for 2006 or 2007.

Figure 40:Chemical Use History for McGinnis Lake

Year	Aquathol	Diquat	Cutrine	Reward	K-Tea	CuSO4
	(gal) or (lbs)	(gal)	(gal) or (lbs)	(gal)	(gal)	(lbs)
1986		8 gal	10 lbs			
1987		6 gal	30 lbs			
1988		6 gal	20 lbs			
1991	5 gal	5 gal	5 gal			
1992	5 gal	5 gal	5 gal			
1993	4 gal	8 gal	8 gal			
1994	240 lbs		120 lbs			
1995	3 gal	5 gal	5 gal			
1996	5 gal	5 gal	5 gal			
1997	11 gal			5.5 gal		25 gal
1998	5 gal		54 gal	3 gal		
1999	10 gal			5 gal	7.5 gal	
2000	8 gal		17.9 gal	4.5 gal		
2001	10.5 gal		25.66 gal	8.6 gal		
2003	27 gal		8.98 gal			
2004	27 gal		13.5 gal			
2005	60 gal					
total	**180.5 gal**	**48 gal**	**148.04 gal**	**26.6 gal**	**7.5 gal**	**25 gal**
	249 lbs		**180 lbs**			

Cutrine and CuSO4 are copper products that were used to kill algae and reduce swimmer's itch (Table 2). . Since copper is an element, it does not biodegrade further, building up the sediments. The drawbacks of copper treatments are:

- the very short effective time
- the toxicity of copper to aquatic insects, an important part of the food chain in a lake
- the build up of copper in the sediments, resulting in sediments that are toxic to mollusks that are the natural consumers of algae in a lake.

Based on water clarity, chlorophyll and phosphorus data, McGinnis Lake is a mesotrophic impoundment with good water clarity and fair to good water quality. This trophic state should support abundant plant growth and occasional algal blooms. The Average Coefficient of Conservatism of the aquatic plant community in McGinnis Lake is below average for Wisconsin lakes and for lakes in the North Central Hardwood region, but the Floristic Quality Index was above average. The AMCI is in the average range for both North Central Hardwood Region and all Wisconsin lakes. Filamentous algae were over-abundant. Structurally, the aquatic plant community contains emergent plants, free-floating plants, floating-leaf rooted plants and submergent plants.

Recommendations for Aquatic Plant Management from the 2006 survey were:

(1) Because the plant cover in the littoral zone of McGinnis Lake is over the ideal (25%-85%) coverage for balanced fishery, consideration should be given to reducing plant growth in at least some areas. A map of areas to have plants removed should be developed, then removal should occur by hand to be sure that entire plants are removed and to minimize the amount of disturbance to the settlement.
(2) Natural shoreline restoration and erosion control in some areas are needed, especially on some steep banks around the deeper lobe of the lake.
(3) A buffer area of native plants should be restored on those sites that now have traditional lawns mowed to the water's edge.
(4) Stormwater management of the impervious surfaces around the lake is essential to maintain the high quality of the lake water.
(5) Septic systems around the lake should be inspected regularly and maintained properly.
(6) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore.
(7) The aquatic plant management plan should be updated regularly. The plan should consider including target treatment using chemicals or target harvesting for Curly Leaf Pondweed to prevent further spread, as well as avoiding sensitive areas.
(8) The McGinnis Lake Association may want to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.
(9) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to invasion by EWM.
(10) Fallen trees should be left at the shoreline.
(11) McGinnis Lake should participate in the Self-Help Monitoring Program through the WDNR.
(12) McGinnis Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.
(13) Critical habitat areas were formally determined in 2004. The lake management plan should include preserving these areas and following the recommendations of the 2005 Sensitive Area Report.

(14) The areas where there are undisturbed wooded shores should be maintained and left undisturbed.

(15) The McGinnis Lake District should make sure that its lake management plan that takes into account all inputs from both the surface and ground watersheds and addresses the concerns of the overall lake community.

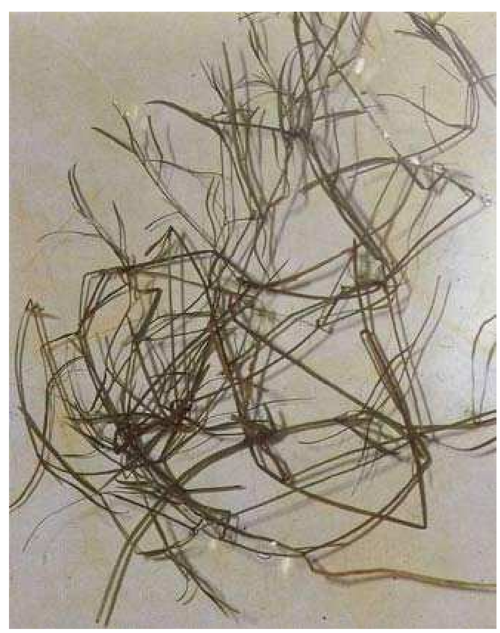
(16) Cooperation with the Adams County Parks Department in keeping the boat ram in safe condition should help reduce any negative impacts caused by the heavy use of this public area.

Myriophyllum sibiricum
(Northern watermilfoil)

Ceratophyllum demersum
(Coontail)

Figure 41: Some Common Native Aquatic Species in McGinnis Lake

Potomogeton pectinatus
(Sago Pondweed)



Aquatic Invasives

McGinnis Lake has two known invasive aquatic species: Curly-Leaf Pondweed (submergent) and Reed Canarygrass (emergent). The lake gets a significant amount of transient boat traffic due to its location (right off a main highway) and the two public boat ramps. The McGinnis Lake Association has a lake management plan that includes management of aquatic invasives. In 2008, volunteer lake citizens will be trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program.

Figure 42: Distribution of Exotic Aquatic Plants in 2004

Figure 43: Curly-Leaf Pondweed, the abundant invasive exotic in McGinnis Lake

Potamogeton crispus
(Curly-Leaf Pondweed)

Figure 44: ***Phalaris arundinacea***
(Reed Canarygrass), the other invasive at McGinnis Lake

Critical Habitat

Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

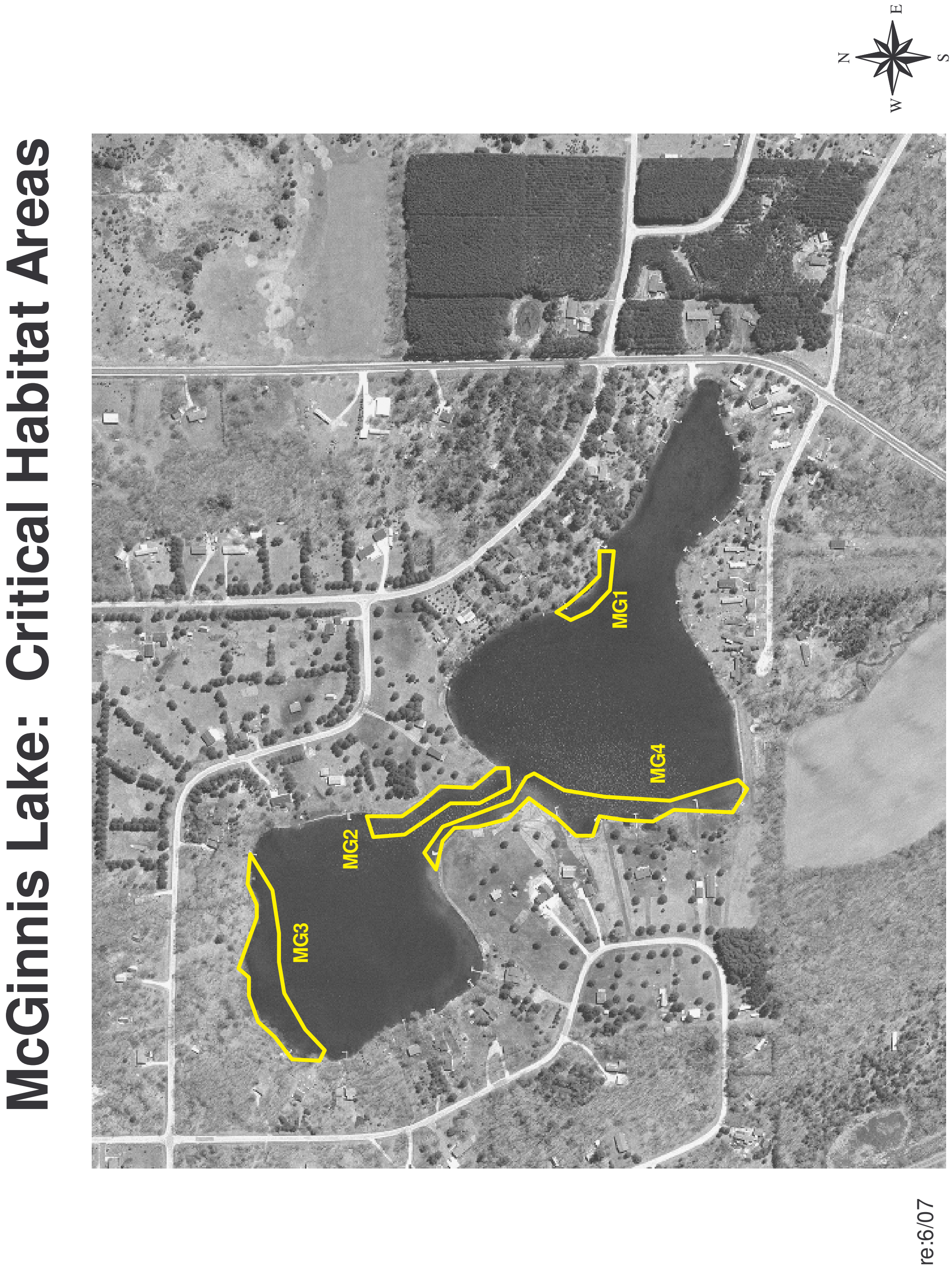
Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shore.

Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

Field work for a critical habitat area study was performed on July 2, 2004, on McGinnis Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Deborah Konkel, DNR Aquatic Plant Specialist; Buzz Sorge, DNR Lakes Biologist and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with digital photos providing additional information. Input was also gained from Terry Kafka, DNR Water Regulation, and Jim Keir, WDNR Wildlife Biologist. Four areas on McGinnis Lake were determined to be appropriate for critical habitat designation.

Most of the southern lobe of McGinnis Lake is developed, with few buffers and several lawns extending to the shore. Although not determined critical habitat areas, they are still important to the overall health of the lake, since those areas are vulnerable to erosion, runoff and sediment deposition that may ultimately be moved by the water into the critical habitat areas and cause those areas to degrade.

Figure 45: Critical Habitat Map of McGinnis Lake



Area MG1

MG1 is extends along approximately 200 feet of shoreline and supports important near-shore terrestrial habitat composed of mature pines, shoreline habitat and shallow water habitat. The area is scenic and provides visual & sound buffers. The shoreline is 75% pine woods and 25% herbaceous growth. Marsh ferns were found along the wet shore edge. Most of the aquatic plants at this site were submergents, with coontail, Illinois pondweed and sago pondweed abundant. The submergents provide important habitat for the fish community. The plant-like algae, *Chara* spp. (muskgrass), was common here, as were filamentous algae. Curly-Leaf Pondweed was also present here.

Figure 46: Part of MG1

Areas MG2

MG2 is part of the old stream channel before the dam was built. This area covers 500 feet of shoreline and supports near-shore terrestrial habitat and shallow water aquatic vegetation. The shoreline is mostly covered by shrub growth, including willows. The emergents bluejoint grass and reed canarygrass (an invasive) are common. Blue-flag iris dominated the shallow water. Other emergents include softstem bulrush, bulb-bearing water hemlock, cattails and marsh milkweed. Emergent vegetation protects the shoreline, as well as providing important food sources and cover for fish and wildlife and fish spawning habitat. Common submergent plants included bushy pondweed, northern watermilfoil, white water crowfoot and coontail. The dominant submergent plant was clasping-leaf pondweed. Other submergents were also found. Muskgrass and filamentous algae were present. Curly-Leaf Pondweed was also present. This area also provides spawning, nursery, feeding & protective cover sites for northern pike, largemouth bass, bluegill and pumpkinseed.

Figure 47: Part of MG2

Area MG3

Area MG3 extends along 750 feet of steep shoreline and supports important near-shore terrestrial vegetation, shoreline habitat and shallow water habitat. The shoreline was mostly wooded, with about 10% developed. Large woody cover in the shallow water serves as important fish cover and wildlife resting areas. Springs at this site are a water source for the lake. This area has multi-levels of vegetation: emergent, floating-leaf rooted plants, and submergent plants, provides a diverse habitat and feeding chances for fish. Several spawning sites were noted. Mature hardwoods cover much of the terrestrial shore. Emergents common include sedges, blue-flag iris, blue-joint grass and cattails. The rooted floating-leaf plant, water smartweed, was also present. Floating-leaf rooted vegetation dampens wave action and provides fish cover and wildlife habitat. Muskgrass was abundant here. Other submergents included coontail, northern watermilfoil and several species of pondweed. No Curly-Leaf Pondweed was found at this site.

Figure 48: View of Part of MG3

Area MG4

Area MG4 is also part of the old stream channel before the dam was built. The area runs along approximately 1000 feet of shore, part of which is in the channel between the two lake lobes. Both shoreline and shallow water habitat are present. About 60% of the shore is shrub buffer, with the rest of the shore about 10% wetlands and pockets of sedge meadows, and the rest developed with houses. Common emergents include blue-flag iris, sedges, marsh milkweed and cattails. Coontail is abundant here. Other submergents include several species of pondweed. Curly-Leaf Pondweed was not found here. Several spawning beds were noted.

Figure 49: Photo of Part of MG4 (blue heron on dock)

Critical Habitat Recommendations

(1) Maintain current habitat for fish and wildlife.
(2) Maintain snag, cavity and fallen trees along the shore for nesting & habitat.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain any snag/cavity trees for nesting.
(6) Install nest boxes.
(7) Maintain corridor and restore natural shoreline vegetations where cleared to increase wildlife corridor.
(8) Increase buffer width where it is less than 35' lakeward and install buffers where there is currently mowed grass to the shore.
(9) Designate critical habitat areas as no-wake lake areas.
(10) Protect emergent vegetation with no removal of emergent vegetation.
(11) No removal of submergent and floating-leaf vegetation. Minimize aquatic aquatic plant and shore plant removal to maximum 30' wide viewing/access corridor and navigation purposes. Leave as much vegetation as possible to protect water quality and habitat.
(12) Seasonal control of Curly-Leaf Pondweed and other invasives with methods selective for control of exotics.
(13) Use best management practices.
(14) No use of lawn products, including fertilizers, herbicides & other chemicals.
(15) No bank grading or grading of adjacent land.
(16) No pier placement, boat landings, development or other shoreline disturbance in the shore area of the wetland corridor.
(17) No pier construction or other activity except by permit using a case-by-case evaluation and only using light-penetrating materials.
(18) No installation of pea gravel or sand blankets.
(19) Install bank restoration in highly eroded areas. Otherwise, permit no bank restoration unless the erosion index scores moderate or high. Use bioengineering practices only, but not rock riprap, retaining walls or other hard armoring.
(20) No placement of swimming rafts or other recreational floating devices.
(21) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(22) Post exotic species information at public boat landing.
(23) Maintain lake as no gas motor lake.

FISHERY/WILDLIFE/ENDANGERED RESOURCES

WDNR stocking records go back to 1969, when McGinnis Lake was stocked with rainbow trout, bluegills and largemouth bass. Stocking continued into the 1990s, consisting of bluegills, largemouth bass and northern pike. Fish inventories go back to 1963, when the WDNR made the following findings: bluegill and largemouth bass abundant; blackchin shiner, brassy minnow and sunfish common; mud minnow, perch and sucker scarce. A 1980 inventory recommended the installation of an aeration system because of the history of low oxygen and fish kills. Other inventories through the years also found bullheads and pumpkinseed. The most recent inventory revealed that bluegills were the most abundant fish, largemouth bass were common and pumpkinseeds were scarce.

Muskrat are also known to use McGinnis Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well. One endangered species, *Cincindela patruela* (tiger beetle), is reported in the McGinnis Lake watersheds.

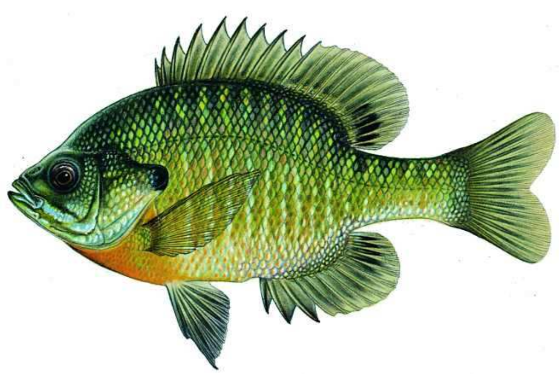


Figure 50: Bluegill (top) and Largemouth Bass (right), common fish in McGinnis Lake

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